ELIIXA+ 8k/4k

Cmos Multi-Line Monochrome Camera

User Manual

Summary

1 CAMERA OVERVIEW

1.1 Features

- Cmos Sensor 4x 8192 Pixels, 5 x 5µm
- Multi-Line structure and Multi-Definition using Binning :
  - 8192 pixels, 5x5µm in 1, 2 or 4 lines summation
  - 4096 pixels, 10x10µm in 1 or 2 lines summation
  - 2048 pixels, 20x20µm
- Interface : CameraLink®
  - BA0 version : Base or Medium, 85MHz down to 60MHz
  - BA1 version : Base, Medium, Full or Deca, 85MHz down to 60MHz
- Line Rate : Up to 100000 l/s
- Data Rate : Up to 850 MB/s
- Bit Depth : 8, 10 and 12bits
- Flat Field Correction
- Look up Table
- Low Power Consumption : < 7,5W
- Compliant with Standard Lenses of the Market (F, T2, M42 Mounts)
- Full Exposure Control, even in 4S "TDE" mode

1.2 Key Specifications

Note : All values in LSB are given in 12 bits format

Characteristics	Typical Value	Unit
Sensor Characteristics at Maximum Pixel Rate		
Resolution	4 x 8192	Pixels
pixel size (square)	5 x 5	µm
Max Line Rate (BA0/BA1 versions, 8 or 12bits)		
CameraLink Base 2 x 85MHz : 8k/4k	20/40	kHz
CameraLink Medium 4 x 85MHz: 8k/4k	40/80	kHz
Max Line Rate (BA1 version only, 8 bits)		
CameraLink Full 8 x 85MHz: 8k/4k	80/100	kHz
CameraLink Deca 10 x 85MHz: 8k/4k	100/100	kHz
Radiometric Performance at Maximum Pixel Rate and minimum camera gain		
Bit depth	8, 10 and 12	Bits
Response (broadband)	450	LSB/(nJ/cm²)
Full Well Capacity	27300 (in 2S or 4S mode and MultiGain at 1/2)	electrons
Response non linearity	0,3	%
PRNU HF Max	3	%
Dynamic range (1S / 2S / 4S mode)	67,6 / 70,7 / 68,7	dB

Functionality (Programmable via Control Interface)		
Sensor modes : Multi-definition, Multi-sensitivity	8k Pixels 5µ m : Multi-Lines 1, 2 or 4 4k Pixels 10µm : Binning 1 or 2 Lines 2k Pixels 20µm : Binning 4x4, 1 line	
Analog Gain	Up to 12 (x4)	dB
Offset	-4096 to +4096	LSB
Trigger Mode	Timed (Free run) and triggered (Ext Trig, Ext ITC) modes	
Mechanical and Electrical Interface		
Size (w x h x l)	125 x 60 x 35	mm
Weight	360	g
Lens Mount	F-Mount, T2 and M42x1	-
Sensor alignment (see chapter 2.1)	±100	µm
Sensor flatness	50	µm
Power supply	Single 12 DC to 24 DC	V
Power dissipation - CameraLink	< 7,5	W
General Features		
Operating temperature	0 to 55 (front face) or 70 (Internal)	°C
Storage temperature	-40 to 70	°C
Regulatory	CE, FCC and RoHS compliant	

1.3 Description

e2v's next generation of line scan cameras are setting new, high standards for line rate and image quality. Thanks to e2v's recently developed multi-line CMOS technology, the camera provides an unmatched 100,000 lines/s and combines high response with an extremely low noise level; this delivers high signal to noise ratio even when short integration times are required or when illumination is limited. The 5µm pixel size is arranged in four active lines, ensuring optimal spatial resolution in both scanning and sensor directions with standard F-mount lenses. Vertical and horizontal binning functions allow the camera to be operated in a 8,192 pixels, 5µm x 5µm pixel pitch, 4 active CMOS lines mode or 4,096 pixels, 10µm x 10 µm pixel pitch, 2 active CMOS lines mode depending on the user settings. This versatile feature sets new standard for next generation machine vision systems

1.4 Typical Applications

- Raw material surface inspection
- General inspection
- Flat panel display inspection
- PCB inspection
- Solar cell inspection
- Parcel and postal sorting
- High resolution document scanning
- Print and paper inspection

CAMERA PERFORMANCES

1.5 Camera Characterization

	Unit	Mode 1S (0dB		Mode 2S (0dB)		Mode 4S (0dB)		Mode 1SB (0dB)		Mode 2SB (0dB)		Mode 4SB (0dB)	
		Typ.	Max	Typ.	Max	Typ.	Max	Typ.	Max	Typ.	Max	Typ.	Max
Dark Noise RMS	LSB	1,7	2,2	2,4	3,1	3	4	*tbd*	*tbd*	*tbd*	*tbd*	*tbd*	*tbd*
Dynamic Range	-	2394:1	-	3412:1(*)	-	2730:1(*)	-	*tbd*	-	*tbd*	-	*tbd*	-
Readout Noise	e-	5,7	-	8	-	10	-	*tbd*	-	*tbd*	-	*tbd*	-
Full Well Capacity	e-	13650	-	27300	-	27300	-	54600	-	54600	-	109200	-
SNR	dB	40	-	43(*)	-	43(*)	-	*tbd*	-	*tbd*	-	*tbd*	-
Peak Response (660nm)	LSB/ (nJ/cm2)	137	-	274	-	547	-	550	-	1100	-	2200	-
Non Linearity	%	0,3	-	0,3	-	0,3	-	0,3	-	0,3	-	0,3	-
Without Flat Field Correction :													
FPN rms	LSB	0,4	1,5	0,7	1,5	0,8	*tbd*	*tbd*	*tbd*	*tbd*	*tbd*	*tbd*	*tbd*
FPN pk-pk	LSB	3,2	15	5	15	5,6	*tbd*	*tbd*	*tbd*	*tbd*	*tbd*	*tbd*	*tbd*
PRNU hf (3/4 Sat)	%	0,13	0,25	0,1	0,25	0,1	*tbd*	*tbd*	*tbd*	*tbd*	*tbd*	*tbd*	*tbd*
PRNU pk-pk (3/4 Sat)	%	1	3	0,8	3	0,8	*tbd*	*tbd*	*tbd*	*tbd*	*tbd*	*tbd*	*tbd*

Test conditions :

- Figures in LSB are for a 12bits format.
- Measured at exposure time = 50µs and line period = 50µs in Ext Trig Mode (Max Exposure Time)
- Maximum data rate
- Stabilized temperature 30/40/55 °C (Room/Front Face/Internal)
- SNR Calculated at 75% Vsat with minimum Gain.

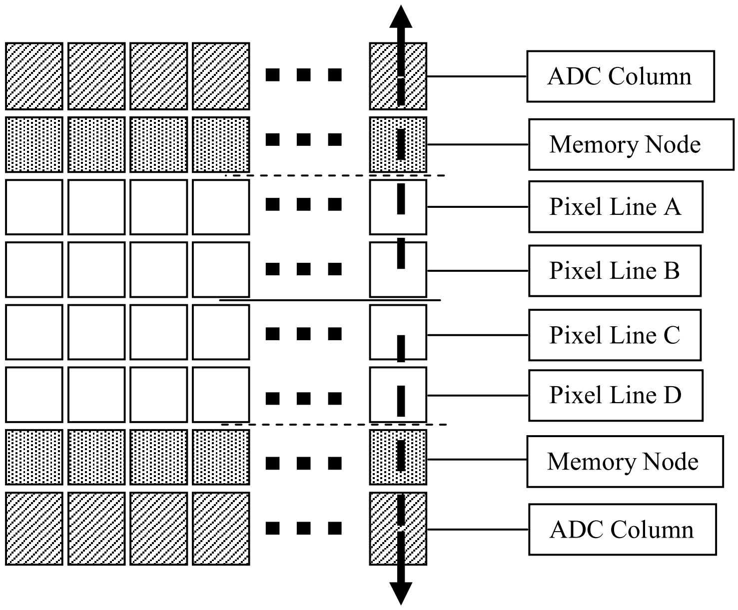
(*) In mode 2S/4S, only with the use of the Multi-Line Gain

1.6 Image Sensor

The Eliixa+ 8k sensor is composed of two pairs of sensitive lines. Each pair of lines use the same Analog to Digital Column converter (ADC Column). An appropriate (embedded) Time delay in the exposure between each line allows combining two successive exposures in order to double the sensitivity of a single line.

This Time Delay Exposure is used only in the 4S multi-line modes (4 Lines) and also in the three binning modes, as described below.

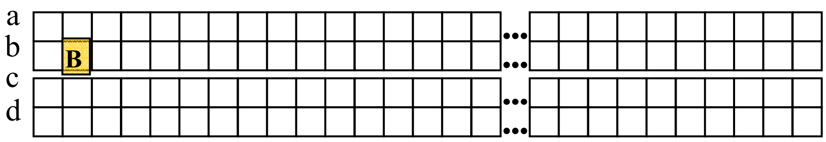
The 8192 Pixels of the whole sensor are divided in 2 blocks of 4096 pixels.



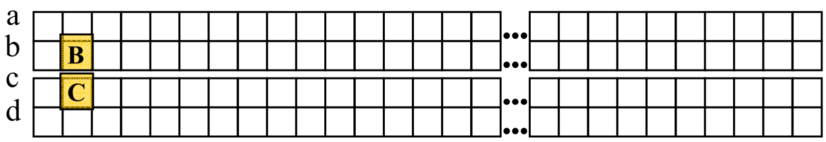
1.7 Sensor modes

8K Pixels Output

Mode 1S = B

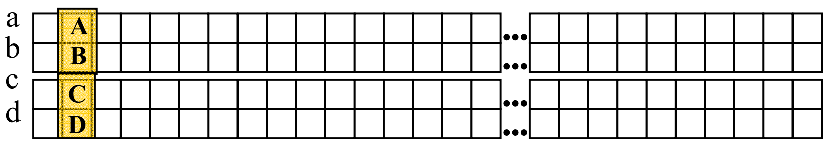


Mode 2S = B+C (FPGA)



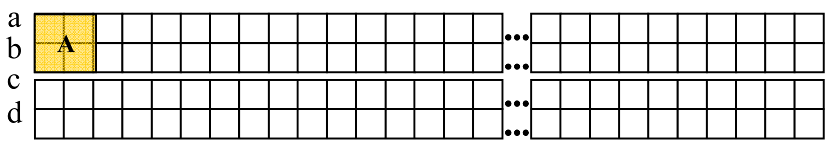
Mode 4S = (A.B)+(C.D)

Note : (A.B) = summation in the sensor

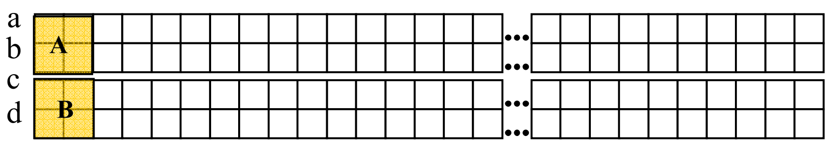


4k Pixels Output

Mode 1SB = A

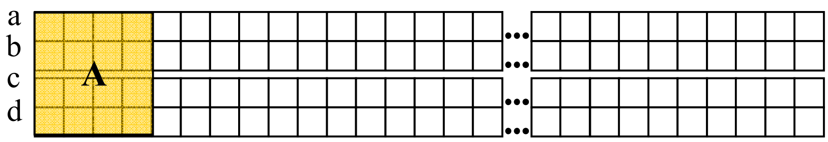


Mode 2SB = (A+B)



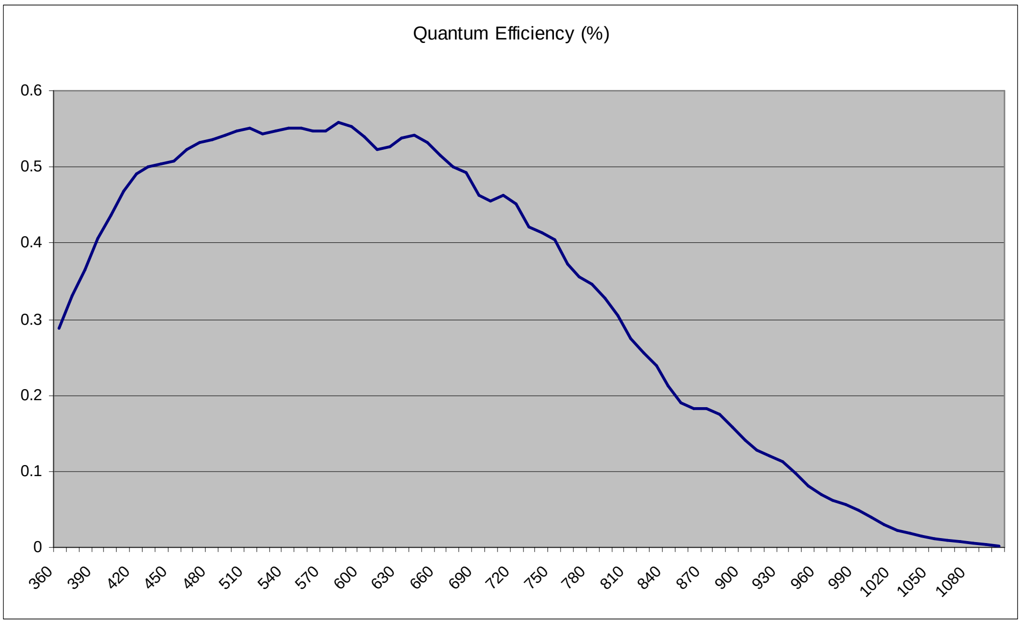
2k Pixels Output

Mode 4SB = A

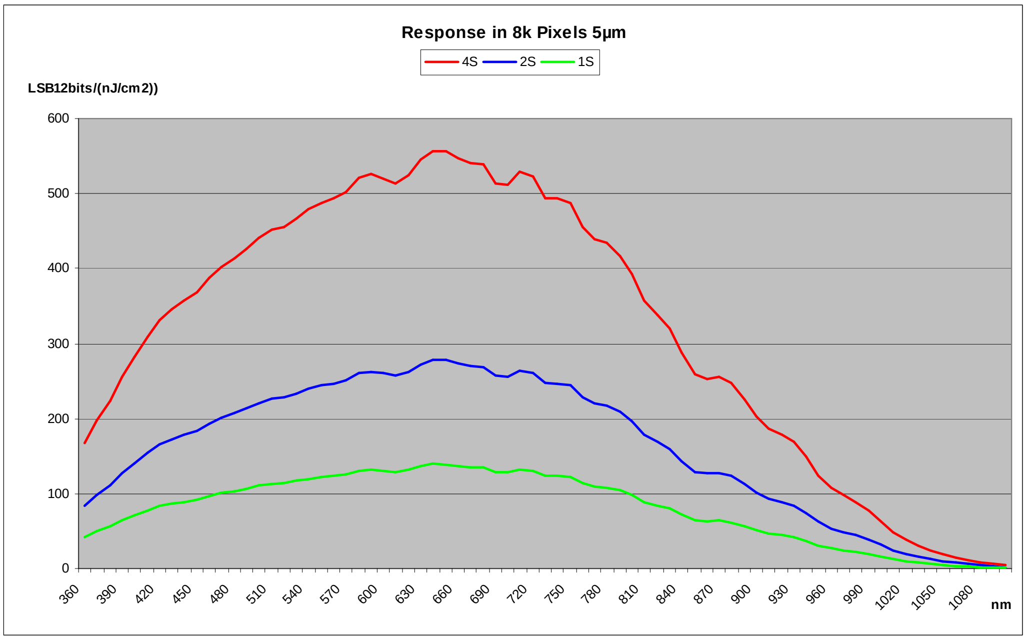


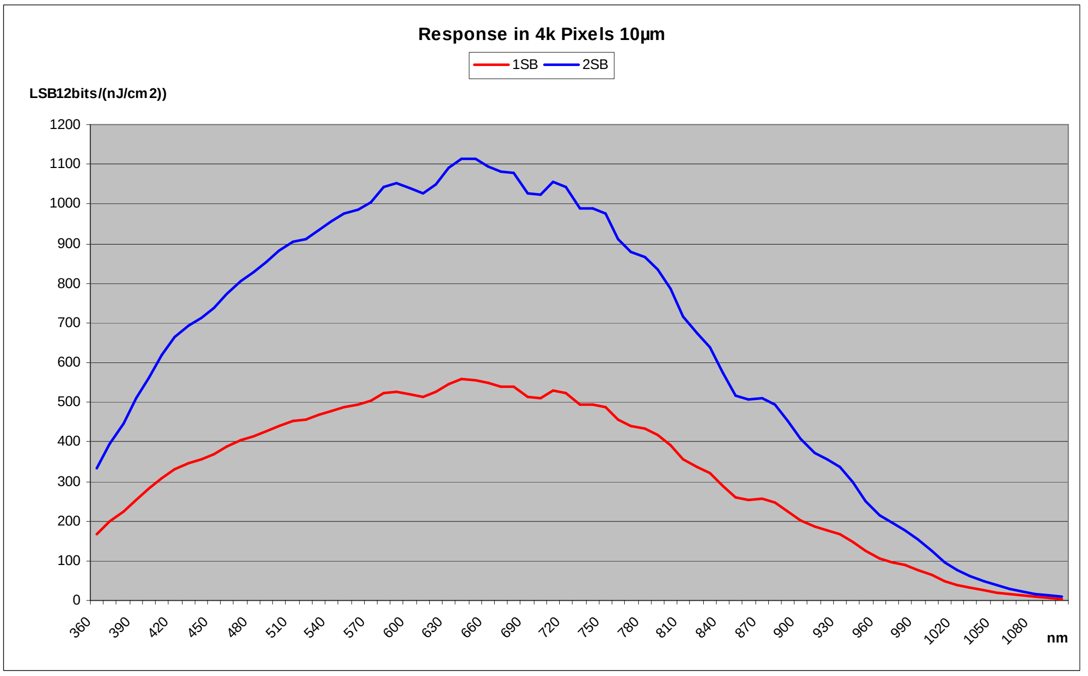
1.8 Response & QE curves

1.8.1 Quantum Efficiency

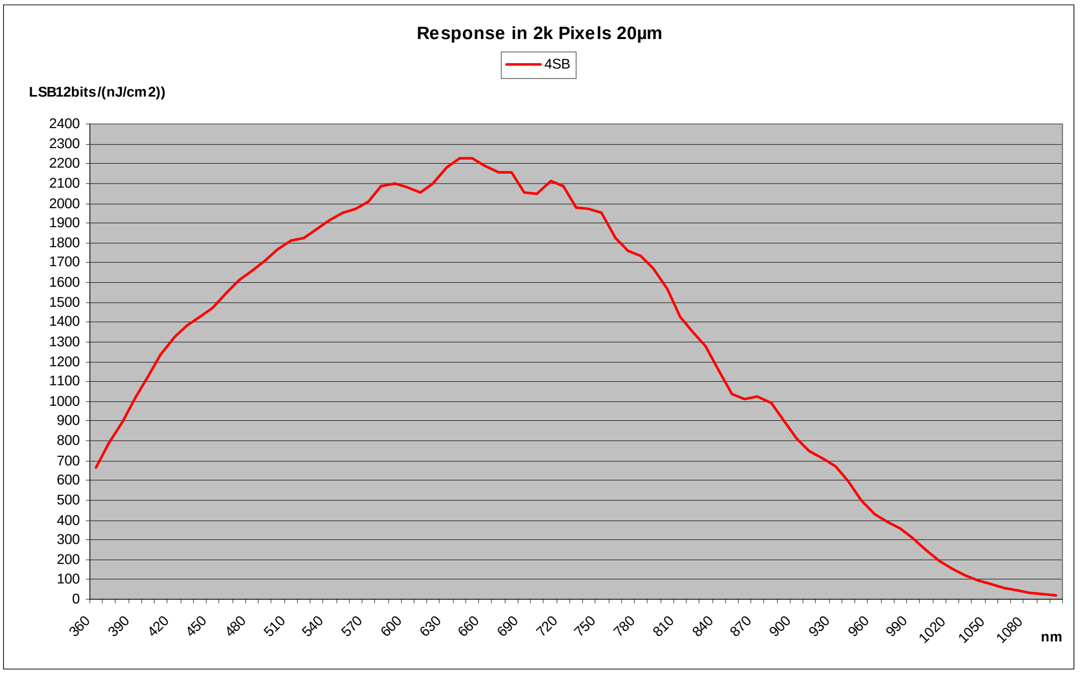


1.8.2 Spectral Response





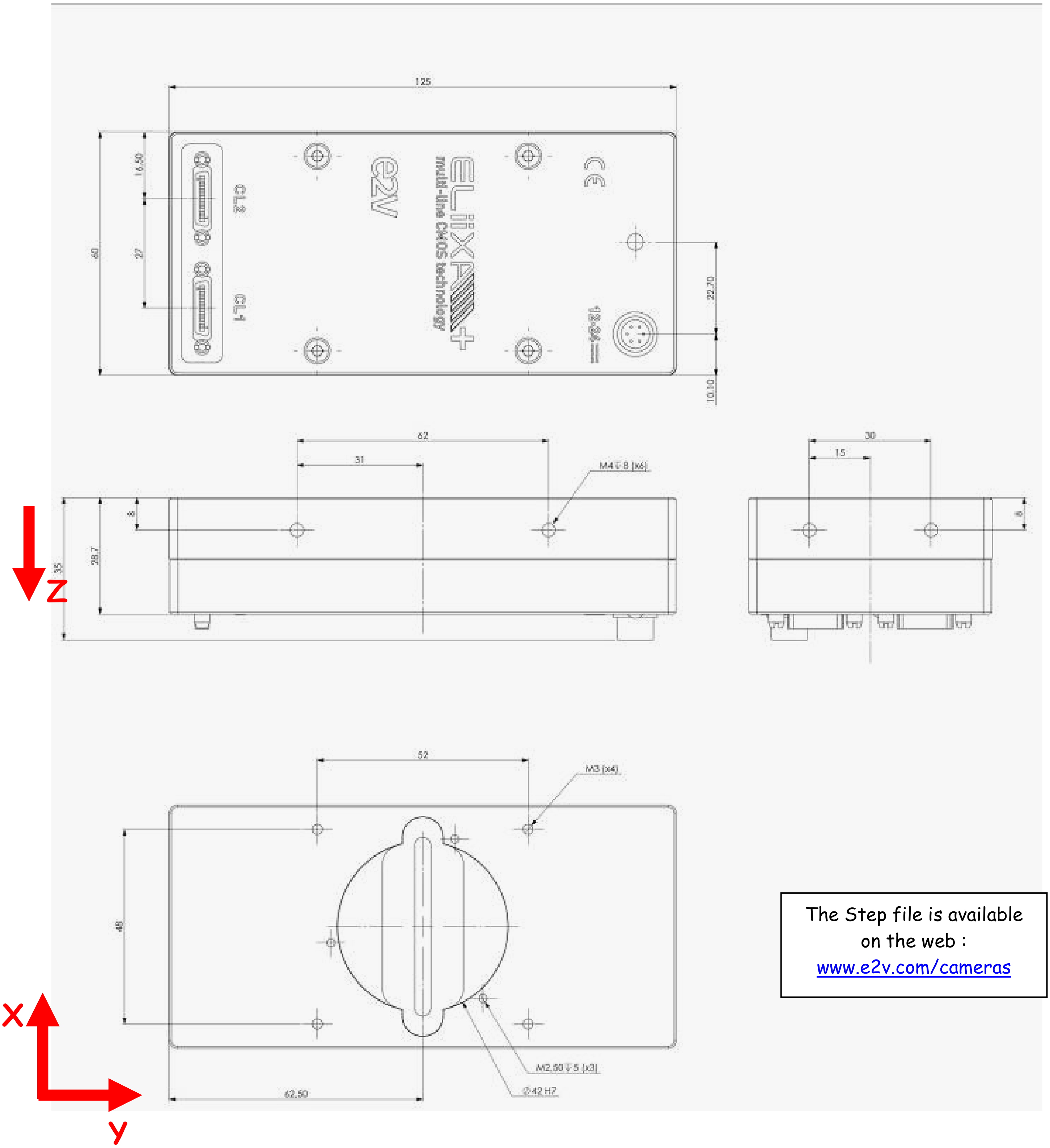
Response in 4k Pixels 10µm
1SB
2SB
LSB12bits/(nJ/cm2))
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
360
390
420
450
480
510
540
570
600
630
660
690
720
750
780
810
840
870
900
930
960
990
1020
1050
1080
nm



Response in 2k Pixels 20µm
4SB
LSB12bits/(nJ/cm2))
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
360
390
420
450
480
510
540
570
600
630
660
690
720
750
780
810
840
870
900
930
960
990
1020
1050
1080
nm

2 CAMERA HARDWARE INTERFACE

2.1 Mechanical Drawings



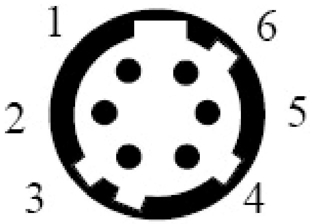
The Step file is available on the web : www.e2v.com/cameras

Sensor alignment	
Z = -10.3 mm	±100µm
X = 9.5 mm	±100 µm
Y = 62.5mm	±100 µm
Flatness	50 µm
Rotation (X,Y plan)	±0,15°
Tilt (versus lens mounting plane)	50µm

2.2 Input/output Connectors and LED

2.2.1 Power Connector

Camera connector type: Hirose HR10A-7R-6PB (male)
Cable connector type: Hirose HR10A-7P-6S (female)



Camera side description

Signal	Pin	Signal	Pin
PWR	1	GND	4
PWR	2	GND	5
PWR	3	GND	6

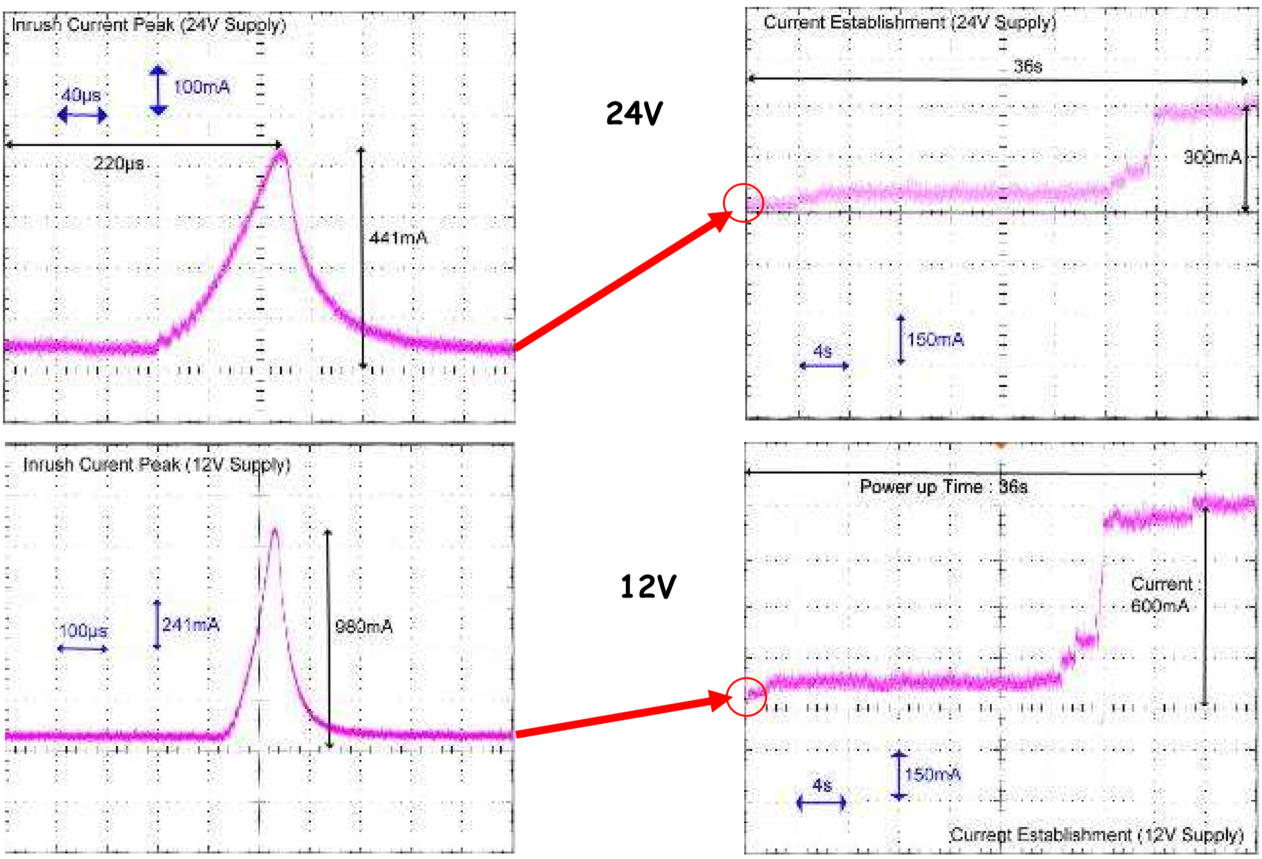
Power supply from 12 to 24v
Power 7,5W max with an typical inrush current peak of **1A** during power up

Typical current/Power during the grab (possible variation : +/- 5%)

Camera supply (Line Period Minimum)	**Supply 12V**		**Supply 24V**	
	I(mA)	**P(W)**	**I(mA)**	**P(W)**
Full 8Taps	605	7.26	303	7.272
Deca 10Taps	613	7.356	308	7.392
Base 2Taps	589	7.068	298	7.152
Medium 4Taps	598	7.176	302	7.248

Power Time : Max 40s (Green Light)

<u>Inrush Current Peak</u> **<u>Current Establishment time and level</u>**



2.2.2 Status LED Behaviour

After less than 2 seconds of power establishment, the LED first lights up in ORANGE. Then after a Maximum of 40 seconds, the LED must turn in a following colour :

Colour and state	Meaning
Green and continuous	OK
Green and blinking slowly	Waiting for Ext Trig (Trig1 and/or Trig2)
Red and continuous	Camera out of order : Internal firmware error

2.2.3 CameraLink Output Configuration

	Adjacent Channels	Pixels per Channel
Versions BA0/BA1		
Base : 2 Channels 8/10/12bits	2 x 85MHz (80/75/70/65/60MHz)	2 x 4096
Medium : 4 Channels 8/10/12bits	4 x 85MHz (80/75/70/65/60MHz)	4 x 2048
Version BA1 (only)		
Full : 8 Channels 8bits	8 x 85MHz (80/75/70/65/60MHz)	8 x 1024
Deca : 10 Channels 8bits	10 x 85MHz (80/75/70/65/60MHz)	10 x 819

3 STANDARD CONFORMITY

The ELIIXA+ cameras have been tested using the following equipment:

- A shielded power supply cable
- A Camera Link data transfer cable ref. MVC-1-1-5-2M from CEI (Component Express, Inc.)

e2v recommends using the same configuration to ensure the compliance with the following standards.

3.1 CE Conformity

The ELIIXA+ cameras comply with the requirements of the EMC (European) directive 2004/108/CE (EN50081-2, EN 61000-6-2).

3.2 FCC Conformity

The ELIIXA+ cameras further comply with Part 15 of the FCC rules, which states that: Operation is subject to the following two conditions:

- This device may not cause harmful interference, and
- This device must accept any interference received, including interference that may cause undesired operation

This equipment has been tested and found to comply with the limits for Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Warning: Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

3.3 RoHs Conformity

ELIIXA+ cameras comply with the requirements of the RoHS directive 2002/95/EC.

Declaration Number: NE31S209097

We, **e2v semiconductors**
rue de Rochepleine
38120 Saint-Egrève
France

declare the product(s)

Product Family: ***EliiXA+ 8k Cameras***

Model Identification: **EV71YC4MCL8005-Bxx**
x = 0-9-A-Z

---

in conformance with the requirements of the following standards:

EN55022 : ed. 2006, A class

EN61000-6-2 : ed. 2005
IEC 61000-4-2 : ed.2009
IEC 61000-4-3 : ed.2006 + A1/2008 +A2/2011
IEC 61000-4-4 : ed.2004
IEC 61000-4-5 : ed.2006
IEC 61000-4-6 : ed.2009
IEC 61000-4-11: ed.2004

when used in conformity with the recommended set-up (as per the Product Specification or Data Sheet).

---

applicable to: **Information Technology Equipments (I.T.E.)**

This (These) product(s) complies(y) with the requirements of the:

- Electromagnetic Compatibility Directive 2004/108/EC,
- CE Marking European Directive 93/68/EEC

and carry the CE marking accordingly.

Saint-Egrève, France, on January 7th, 2013

Martine WOOLF,
Quality Manager
Martine Woolf – Responsable QSE

 Printed form FC.32S.15908.0/B

e2vsemiconductors• Avenue de Rochepleine• BP 123 • 38521 Saint Egreve Cedex • France

4 GETTING STARTED

4.1 Out of the box

The contains of the Camera box is the following :

- One Camera ELIIXA+
- Power connector (Hirose HR10A-7P-6S -female)

There is no CDROM delivered with the Camera : Both User Manual (this document) and CommCam control software have to be downloaded from the web site : This ensure you to have an up-to-date version.

*Main Camera page : **www.e2v.com/cameras***

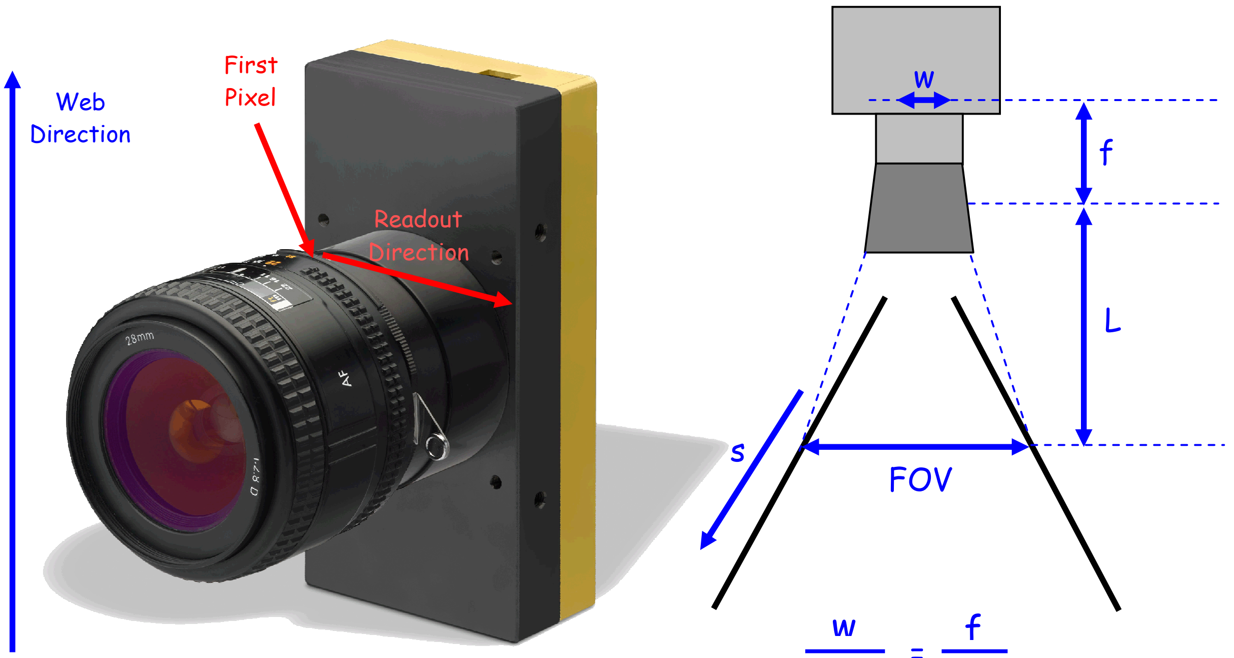
On the appropriate Camera Page (ELIIXA+ 8k/4k) you'll find a download link

first version of CommCam compliant is indicated in the last Chapter

CommCam download requires a login/password :

- *Login : **commcam***
- *Password : **chartreuse***

4.2 Setting up in the system



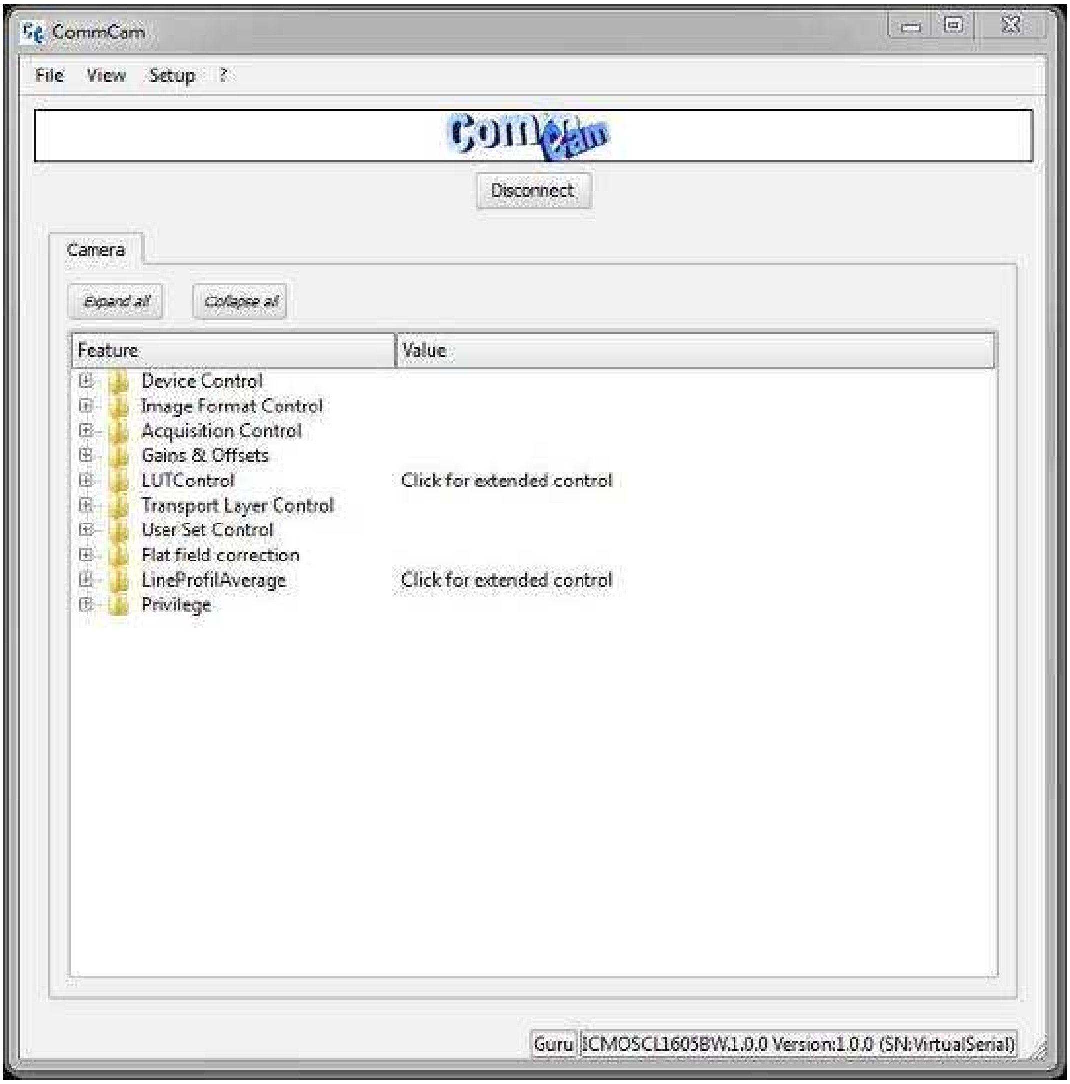
$$\frac{w}{FOV} = \frac{f}{L}$$

The Compliant Lenses Mounts are detailed in Appendix D

5 CAMERA SOFTWARE INTERFACE

5.1 Control and Interface

As all the e2v Cameras, the ELIIXA+ CL is delivered with the friendly interface control software COMMCAM.UCL (as "Ultimate Camera Link") which is based on the GenICam standard
COMMCAM recognizes and detects automatically all the UCL Cameras connected on any transport layers (Camera Link or COM ports) of your system.
Once connected to the Camera you have an easy access to all its features. The visibility of these features can be associated to three types of users: Beginner, Expert or Guru. Then you can make life easy for simple users.
Minimum version of CommCam is 2.1.4 in order to recognize the ELIIXA+ 8k/4k Camera (both versions)



5.2 Serial Protocol and Command Format

The Camera Link interface provides two LVDS signal pairs for communication between the camera and the frame grabber. This is an asynchronous serial communication based on RS-232 protocol.
The serial line configuration is:

- Full duplex/without handshaking
- 9600 bauds (default), 8-bit data, no parity bit, 1 stop bit. The baud rate can be set up to 115200

5.2.1 Syntax

Internal camera configurations are activated by write or readout commands.
The command syntax for write operation is:

w <command_name> <command_parameters><CR>

The command syntax for readout operation is:

r <command_name><CR>

5.2.2 Command Processing

Each command received by the camera is processed:

- The setting is implemented (if valid)
- The camera returns ">"<return code><CR>

The camera return code has to be received before sending a new command.

The camera return code has to be received before sending a new command. Some commands are longer than the others : Waiting for the return code ensure a good treatment of all the commands Without saturating the buffer of the camera

Table 5-1. Camera Returned Code

Returned code	meaning
>0	(or ">OK") : All right, the command will be implemented
>3	Error Bad CRC (for write command only)
>16	Invalid Command ID (Command not recognized or doesn't exist)
>33	Invalid Access (the receipt of the last command has failed).
>34	Parameter out of range (the parameter of the last command sent is out of range).
>35	Access Failure (bad communication between two internal devices).

5.2.3 GenICam ready

The CameraLink Standard is not yet compliant with GenICam Standard, but as much as possible, each command of the ELIIXA+ will have its correspondence with the Standard Feature Naming Convention of the GenIcam Standard.
This correspondence is given in parenthesis for each feature/command as the following example :

- **Vendor name** (*DeviceVendorName*) : "**e2v**"

5.3 Camera Commands

5.3.1 Information

These values allow to indentify the Camera. They can be accessed in CommCam software in the "Info" section

All these values are fixed in factory and can't be changed (shaded) except the Camera User ID which can be fixed by the Customer :

- **Vendor name** (*DeviceVendorName*) : "e2v"
  ⇨ Read function : "**r vdnm**";
  Returned by the camera : "e2v", string of 32 bytes (including "/0")
  ⇨ Can not be written

- **Model Name** (*DeviceModelName*) : Internal name for GenICam :
  ⇨ Read function : "**r mdnm**";
  Returned by the camera : String of 32 bytes (including "/0") :
  ⇨ Can not be written

- **Device Manufacturer Info** (*DeviceManufacturerInfo*) : Get Camera ID
  ⇨ Read function : "**r idnb**";
  Returned by the camera : String of 128 bytes (including "/0")
  ⇨ Can not be written

- **Device Version** (*DeviceVersion*) : Get Camera Hardware version
  ⇨ Read function : "**r dhwv**";
  Returned by the camera : String of 32 bytes (including "/0")
  ⇨ Can not be written

- **Device Firmware Version** (*DeviceFirmwareVersion*): Get camera synthetic firmware
  ⇨ Read function : "**r dfwv**";
  Returned by the camera : String of 16 bytes (including "/0")
  ⇨ Can not be written

- **Device SFNC Version : 1.5.0**
  These Parameters (Major, Minor, Sub Minor) are only virtual ones in order to give the SFNC compliance of the Camera.

- **Device ID** (*DeviceID*) : Camera Factory identifier ID
  ⇨ Read function : "**r cust**";
  Returned by the camera : String of 128 bytes (including "/0")
  ⇨ Write function : "**w cust <idstr>**"

- **Device User ID** (*DeviceUserID*) : Camera user identifier ID
  ⇨ Read function : "**r cust**";
  Returned by the camera : String of 128 bytes (including "/0")
  ⇨ Write function : "**w cust <idstr>**"

- **Electronic board ID** (*ElectronicBoardID*) : Get PcB Board ID
  - ⇨ Read function : "**r boid**";
    Returned by the camera : String of 32 bytes (including "/0")
  - ⇨ Can not be written

- **Device Temperature Selector** (*DeviceTemperatureSelector*) : **MainBoard**
  - ⇨ Can not be written

- **Device Temperature** (*DeviceTemperature*) : Get Main Board Temperature
  - ⇨ Read function : "**r temp**";
    Return by the camera : Temperature in Q10.2 format (8 bits signed + 2 bits below comma). Value is between -512 to 511 in °C.

- **Device Serial Port Selection** : Indicates the Serial Port on which the Camera is connected.

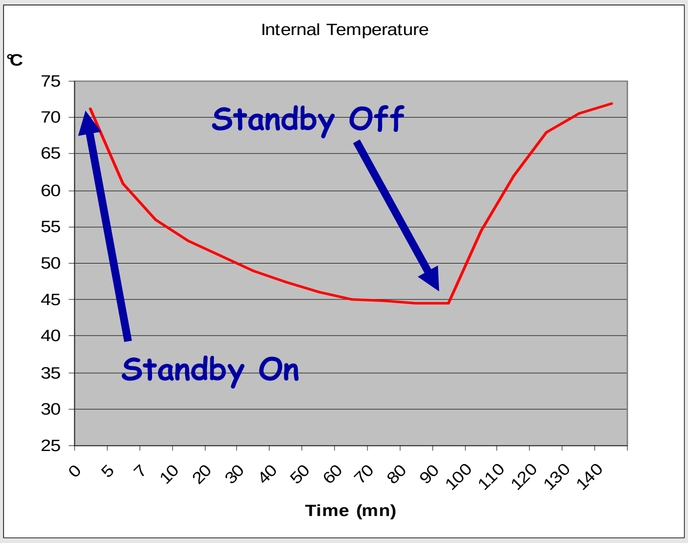
- **Device Serial Port Baud Rate** (*ComBaudRate*): Set the Camera BaudRate
  - ⇨ Read function : "**r baud**";
    Returned by the camera : Value of the Baud Rate
  - ⇨ Write function : "**w baud**" <index> with the index as follows :
    - 1 : 9600 Bauds (default value at power up)
    - 2 : 19200Bauds
    - 6 : 57600Bauds
    - 12 : 115200Bauds

- **Standby Mode** (*Standby*) : Activation of the Standby mode of the Camera
  - ⇨ Read function : "**r stby**";
    Returned by the camera : Boolean.
    - 0 : Disable Standby mode (False)
    - 1 : Enable stanby mode (True)
  - ⇨ Write function : "**w stby <val>**"; <val> is 0 or 1.

A standby mode, what for ?

The Standby mode stops all activity on the sensor level. The power dissipation drops down to about **6W**. During the standby mode, **the grab is stopped**

Once the Standby mode turned off, the Camera recovers in less than **1ms** to send images again from the sensor.



- **Camera status** : Get the Camera status register (32bits Integer)
  - ⇨ Read function : "**r stat**";
    Returned by the camera : 32bits integer :
    - **Bit 0** : (*StatusWaitForTrigger*) : True if no trig received from more than 1sec
    - **Bit 1** : (*StatusTriggerTooFast*) : Missing triggers. Trig signal too fast
    - **Bit 2** : (*StatusSensorConnection*) : True is the Sensor pattern is checked as failed.
    - Bit 3, 4, 5, 6, 7 : Reserved
    - **Bit 8** : (*StatusWarningOverflow*) : True is an overflow occurs during FFC or Tap balance processing.
    - **Bit 9** : (*StatusWarningUnderflow*) : True is an underflow occurs during FFC or Tap balance processing
    - Bits 10 : Reserved
    - **Bits 11** : Scrolling Direction : 0 = Forward, 1 = Reverse. Updated only by external CC3 (CameraLink)
    - Bits, 12, 13, 14, 15 : Reserved
    - **Bit 16** : (*StatusErrorHardware*) : True if hardware error detected
    - Bits 17 to 31 : Reserved

5.3.2 Image Format

- **Sensor Width** (*SensorWidth*) : Get the physical width of the Sensor. This value is available in the CommCam "Image Format Control" section :
  - ⇨ Read function : "**r snsw**";
    Return by the sensor : Integer 8192.
  - ⇨ Can not be written;

- **Sensor Height** (*SensorHeight*) : Get the physical height of the Sensor. This value is available in the CommCam "Image Format Control" section :
  - ⇨ No Access. Virtual command in xml"; Value always = 1

- **Width Max** (*WidthMax*) : Get the Maximum Width of the Sensor. This value is available in the CommCam "Image Format Control" section :
  - ⇨ No Access. The value is mapped on "SensorWidth"

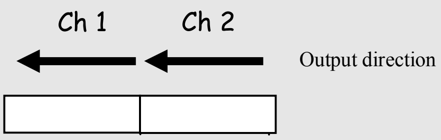
- **Height Max** (*HeigthMax*) : Get the Maximum height of the Sensor. This value is available in the CommCam "Image Format Control" section :
  - ⇨ No Access. Virtual command in xml"; Value always = 1

- **Output mode** (*OutputMode*) : Set the CameraLink Output mode (refer also to Chap 3. : CameraLink Output Configuration). This command is available in the CommCam "Image Format Control" section :
  - ⇨ Read function : "**r mode**";
    Returned by the camera : Output mode from 0 to 3 (see table below).
  - ⇨ Write function : "**w mode"** <value> :
    detailed in the table below :

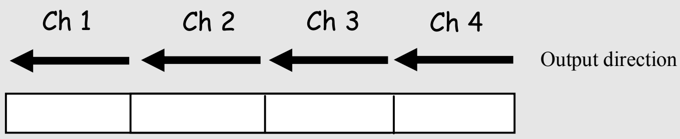
Modes	Connector CL1	Connector CL2	Mode value
Base 2 Channels 8 Bits	2 x 8 bits	-	5
Base 2 Channels 10bits	2 x 10 bits		6
Base 2 Channels 12 Bits	2x 12 bits	-	7
Medium 4 Channels 8bits	4 x 8 bits		0
Medium 4 Channels 10 bits	4 x 10 bits		4
Medium 4 Channels 12bits	4 x 12 bits		1
Full 8 Channels 8bits (BA1 Version Only)	8 x 8 bits		2
Full+ 10 Channels 8bits (BA1 Version Only)	10 x 8 bits		3

Structure of the Camera Link Channels for interfacing

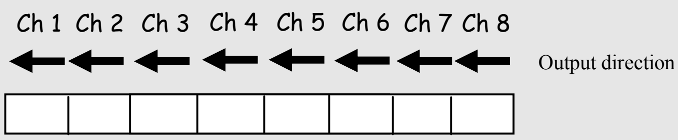
- **Base Mode :** 2 Channels Separate, outputted from Left to Right.
  2x4096 pixels each Channel (No Binning)
  2x2048 pixels in Binning Mode 1SB or 2SB,
  2x512 pixels in Binning mode 4SB.



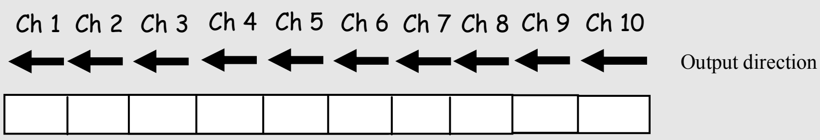
- **Medium Mode :** 4 Taps Separate, outputted from Left to Right
  4x2048 pixels each Channel (No Binning)
  4x1024 pixels in Binning Mode 1SB or 2SB,
  4x512 pixels in Binning mode 4SB.



- **FULL Mode :** 8 Taps Separate, outputted from Left to Right. *Available only on BA1 versions*.
  8x1024 pixels each Channel (No Binning)
  8x512 pixels in Binning Mode 1SB or 2SB,
  8x256 pixels in Binning mode 4SB.



- **FULL+ (Deca) Mode :** 10 Taps Separate, outputted from Left to Right. *Available only on BA1 versions*.
  10x819 pixels each Channel (No Binning)
  10x409 pixels in Binning Mode 1SB or 2SB,
  10x204 pixels in Binning mode 4SB.



- **Output Frequency** (*OutputFrequency*) : Set the CameraLink Data Output Frequency. This value is available in the CommCam "Image Format Control" section :
  ⇨ Read function : "**r clfq**";
  Return by the Camera : Frequency from 0 to 5
  ⇨ Write Function : "**w clfq** <value>"
    - "0" : 85MHz (default).
    - "1" : 60MHz.
    - "2" : 65MHz.
    - "3" : 70MHz.
    - "4" : 75MHz.
    - "5" : 80MHz.

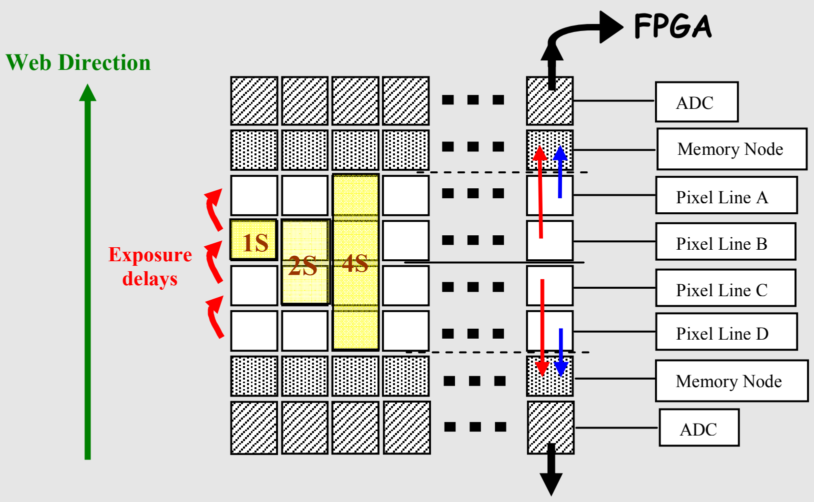
Data Output Frequency Reduction

The Purpose of this feature is to optimize (increase) the Length of the Cable when highest Line Rate is not required. Each decreasing of the Data Frequency will increase the minimum Line Period possible, this depending also on the Binning mode (number of pixels outputted from 8192 to 2048

<u>Structure of the Sensor</u>

In 2S Mode, the summation of the two lines is done in the FPGA :
B+C

In 4S Mode, the summation of the two double lines is done in the FPGA : **(AB)+ (BC)**
This mode works in "Time delay exposure" for the summation of each double line in the sensor.



- **Sensor Mode** (*SensorMode*) : Defines the number of Line used on the Sensor. This command is available in the CommCam "Image Format Control" section :

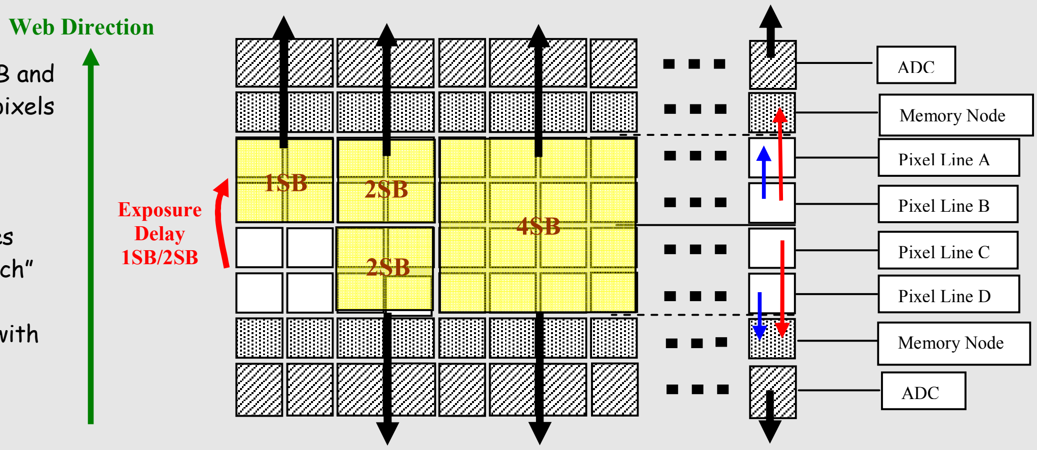
⇨ Read function : "**r smod**";
  Returned by the camera : Integer from 0 to 5
⇨ Write function : "**w smod**" <value> :
- "0" : "1S" mode or Single Line.
- "1" : "2S" mode or Dual Lines.
- "2" : "4S" mode or Four Lines.
- "3" : "1SB" mode : Binning mode (2x2) which outputs on line of 4k pixels in 10µmx10µm.
- "4" : "2SB" mode : Binning mode 2 x (2x2) which outputs the summation of 2 lines of 4k pixels in 10µmx10µm.
- "5" : "4SB" mode : Binning mode (4x4) which outputs 1 line of 2k pixels in 20µmx20µm.

Full Exposure Control

As the « 4S » mode is performing an internal Time delay exposure on the lines A & B and C & D, normally, the variation of the Exposure time should not be possible in this sensor mode. Thanks to an e2v licensed solution, two of the Exposure controlled mode (Ext Trig with internal or External exposure control) are still available in 4S sensor TDE mode.

Binning modes

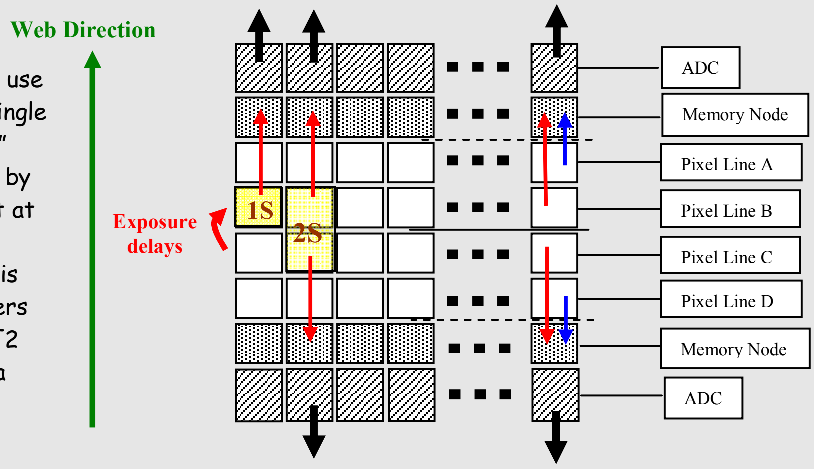
The two binning modes 1SB and 2SB give an output of 4k pixels 10x10µm.
As for the 2SB mode, the sensor manages the delay between the two exposures necessary for a "good match" acquisition.
The 4SB is a binning 4x4 with an output of 2K pixels 20x20µm



- **Multi-Line Gain** (*MultiLineGain*) : Enables the MultiLine Gain of x0,5 . This value is available in the CommCam "Image Format Control" section :
  - ⇨ Read function : "**r mlig**";
    Return by the sensor : "0" if disabled (Gain x1 by default); "1" if Gain x0,5 activated.
  - ⇨ Write Function : "**w mlig** <value>"
    - "0" : Default Gain x1 is active.
    - "1" : Gain x0,5 is enabled (only when the 2S mode of the sensor is enabled)

Why Using a Multi-Line Gain of x0,5 ?

When the Light source is enough to use the "1S" mode of the Sensor (one single line), the best is to use 2 lines ("2S" mode) and then to divide the result by two by using the Multi-Line Gain set at "x0,5" :
In this case, the Full Well capacity is multiplied by x2 (two output registers are used) but the noise divided by √2 therefore the SNR is improved by a factor of √2.



- **Reverse Reading (X)** (*ReverseReading*) : Allows to output the line in the Reverse-X direction. This value is available in the CommCam "Image Format Control" section :
  - ⇨ Read function : "**r revr**";
    Return by the Camera : 0 or 1 (enabled/disabled)
  - ⇨ Write function : "**w revr** <value>";
    - "0" : Disabled.
    - "1" : Enables the reverse reading out (see below for "normal" direction)

- **Scan Direction** (*ScanDirection*) : Set the scan direction for the sensor. This value is available in the CommCam "Image Format Control" section :
  - ⇨ Read function : "**r scdi**";
    Return by the Camera : 0, 1 or 2 (Forward/reverse/external)
  - ⇨ Write function : "**w scdi** <value>";
    - "0" : Forward.
    - "1" : Reverse
    - "2" : Externally controlled (by CC3 of the CameraLink Sync signals)

  Forward/reverse information has to be set correctly as soon as the Mode "2S", "4S" or 2SB of the sensor are set : In these modes, the sensor/Camera need to know what is the real order of the lines for the exposure delays.

The Forward direction is defined as detailed beside :

__Note__ : The minimum delay for the Camera to take in account a change in the ScanDirection value is :
- Using CC3 signal : **100ms**.
- Using serial command(*) : **120ms**

(*) After reception of the Command on the camera side

If the Camera is in **4S** Sensor mode, after changing of the scanning direction, the 5 first following triggers will be ignored in order to reinitialize the "Full Exposure Control" mode. Then the 3 following lines acquired will be more or less black because in 4S, 4 lines are required for a complete exposure.

In **2S or 2SB** Sensor modes, no Trigger will be lost after the change of scanning direction but the first line acquired will be more or less black as in 2S, 2 lines are required for a complete exposure.

In **1S**, **1SB** or **4SB** modes, nothing is lost an all lines received after the delay are correct.

This positioning takes also in account that the mode "Reverse X" is "Off" (Normal readout direction)

- **Test Image Selector** (*TestImageSelector*) : Defines if the data comes from the Sensor or the FPGA (test Pattern). This command is available in the CommCam "Image Format" section :

  ⇨ Read function : "**r srce**";
  Returned by the camera : "0" if Source from the Sensor and "1 to 5" if test pattern active
  ⇨ Write function : "**w srce**" <value> :
    - "0" : To switch to CCD sensor image
    - "1" : Grey Horizontal Ramp (Fixed) : **See AppendixA**
    - "2" : White Pattern (Uniform white image : 255 in 8Bits or 4095 in 12bits)
    - "3" : Grey Pattern (Uniform middle Grey : 128 in 8bits or 2048 in 12 bits)
    - "4" : Black Pattern (Uniform black : 0 in both 8 and 12 bits)
    - "5" : Grey vertical Ramp (moving)

  The test pattern is generated in the FPGA : It's used to point out any interface problem with the Frame Grabber.
  When any of the Test pattern is enabled, the whole processing chain of the FPGA is disabled.

5.3.3 Acquisition Control

This section deals with all the Exposure, Line period and synchronisation modes

- **Synchronisation Mode** (TriggerPreset) : Timed or Triggered, it defines how the grabbing is synchronized. This command is available in the CommCam "Acquisition Control" section :

  ⇨ Read function : "**r sync**";
  Returned by the camera :
    - "**0**" : Internal Line Trigger with Exposure time Internally Controlled (Free Run). *Not available when Sensor mode is set in "4S" (whatever the firmware version)*
    - "**1**" : External Trigger with Exposure Time Internally Controlled. *Available also when Sensor mode is set in "4S".*
    - "**2**" : External Trigger with maximum Exposure time
    - "**3**" : One External with Exposure Time Externally Controlled. The same Trigger signal defines the line period and its low level defines the exposure time. *Available also when Sensor mode is set in "4S"*
    - "**4**" : Two External Triggers with Exposure Time Externally Controlled : CC2 defines the start of the exposure (and also the start Line) and CC1 defines the Stop of the exposure. *Not available when Sensor mode is set in "4S"*
    - "**5**" : Internal Line Trigger with maximum Exposure Time

  ⇨ Write function : "**w sync**" <value>

The Timing diagrams associated to each Synchronization mode and the Timing values associated are detailed in the APPENDIX B of this document.

- **Exposure time** (*ExposureTime*): Defines the exposure time when set in the Camera. This command is available in the CommCam "Acquisition Control" section :

  ⇨ Read function : "**r tint**";
  Returned by the camera : Integer from 15 to 65535 (=1,5µs to 6553,5µs by step o 0,1µs)
  ⇨ Write function : "**w tint**" <value> ;

  This value of exposure time is taken in account only when the synchronisation mode is "free run" (0) or "Ext Trig with Exposure time set" (1). Otherwise it's ignored.

> Due to the limitation of the timing pixel inside the sensor, the Exposure time has to be set by taking in account the limitation detailed in the APPENDIX B of this document.
> The **Minimum exposure time** which can be set is **1,5µs**

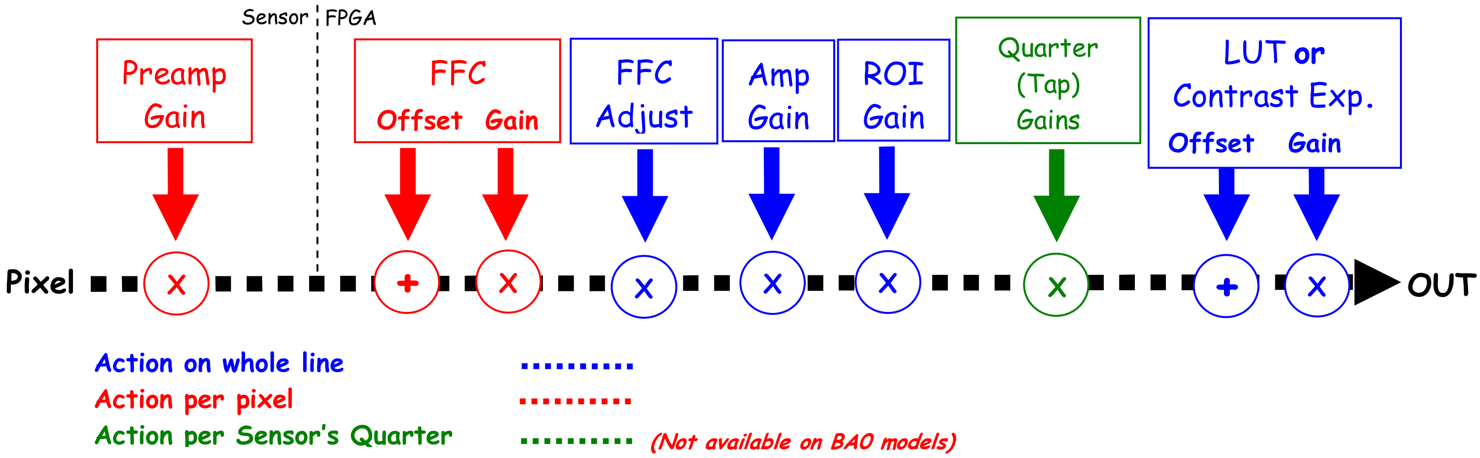
- **Line Period** (*LinePeriod*) : Defines the Line Period of the Camera in Timed mode. This command is available in the CommCam "Acquisition Control" section :

  ⇨ Read function : "**r tper**";
  Returned by the camera : Integer from 1 to 65536 (=0,1µs to 6553,6µs by step o 100ns)
  ⇨ Write function : "**w tper**" <value> ;

  The line period is active only in Free Run modes. It's also disabled if in this mode, the Integration time is set higher than the Line Period.

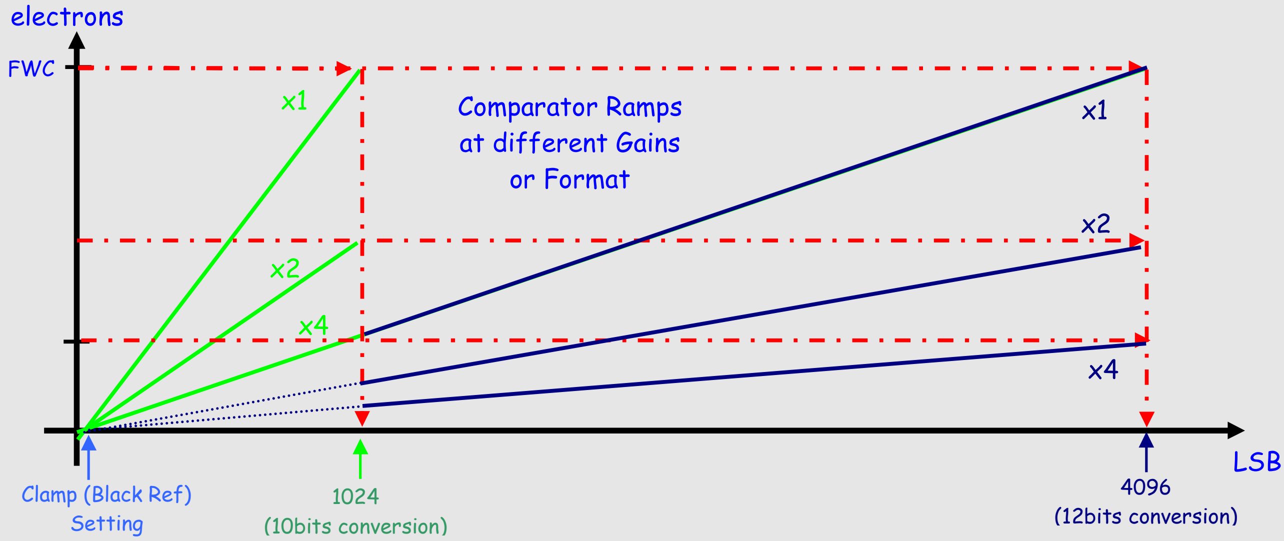
> The Tables of the minimum Line Period (Max Line Rate) versus the Data rate and the output mode chosen are given in Appendix C (Chap. 9.2) of this document.

5.3.4 Gain and Offset



Analog Gain in the ADC

The only analog Gain available in the ELIIXA+ is located at the sensor level, in the ADC converter.
This "Preamp Gain" is in fact a variation of the ramp of the comparator of the ADC.
Then 3 Values are available : x1, x2 and x4. A gain x1 in a 12 bits conversion is equivalent to x4 in 10 bits.



- **Preamp Gain** : (*Gain* with *GainSelector= AnalogAll*)
  Set the Pre-amplification Gain. This command is available in the CommCam "Gain & Offset" section.

  ⇨ Read function : "**r pamp**";
  Returned by the camera : Integer corresponding to one of the 3 different step values :
  - 0 : x1 (0dB)
  - 1 : x2 (6dB)
  - 2 : x4 (12dB)

  ⇨ Write function : "**w pamp**" <int> ;

- **Gain:** (*Gain* with *GainSelector= GainAll*)
  Set the Amplification Gain. This command is available in the CommCam "Gain & Offset" section :
  ⇨ Read function : "**r gain**";
  Returned by the camera : Value from 0 to 6193 corresponding to a Gain range of 0dB to +8dB calculated as following : Gain(dB) = 20.log(1+ Gain/4096).
  ⇨ Write function : "**w gain**" <int> ;

- **Tap Gain (*Gain* with *GainSelector= Tap*X) :**
  ⇨ Read function : "r **fga**<tap>"; <tap> is 1 or 2
  Returns the Gain value for the tap. Ex : "*r fga1*" returns Gain value Tap1.
  ⇨ Write function : "w **fga**<tap> <value>"
  - **<tap>** : 1 or 2
  - **<value> :** from -128 to +127 by step of 1 (0,0021dB each step)

- **Digital Gain** (*Gain* with *GainSelector=DigitalAll*) : Set the global Digital Gain. This command is available in the CommCam "Gain & Offset" section :
  ⇨ Read function : "**r gdig**";
  Returned by the camera : Integer value from 0 to 255. The corresponding Gain is calculated as 20log(1+val/64) in dB
  ⇨ Write function : "**w gdig**" <int> ;

- **Digital Offset** (*BlackLevelRaw* with *BlackLevelSelector=All*) : Set the global Digital Offset. This command is available in the CommCam "Gain & Offset" section :
  ⇨ Read function : "**r offs**";
  Returned by the camera : Value from –4096 to +4095 in LSB
  ⇨ Write function : "**w offs**" <int> ;

> *The Contrast Expansion (both Digital Gain & Offset) will be automatically disabled if the LUT is enabled..*

- **Tap Balance Gains Enable Switch (*TapBalanceGainEnable*) :**
  ⇨ Read function : "r **fgae**";
  Returns the Gain value for the tap. Ex : "*r fga1*" returns Gain value Tap1.
  ⇨ Write function : "w **fgae** <val>" with <val> : 0 or 1
  - 0 : Disables the Tap Balance Gains
  - 1 : Enables the Tap Balance Gains

- **ROI Gain () :** Set the Gain for the ROI Gain feature.
  ⇨ Read function : "r **roig**";
  Returned by the camera : Value from 0 to 2047 (U1.9) corresponding to a Gain range from x1 to x1,999 and calculated as following : (1+ Gain/1024).
  ⇨ Write function : "w **roig**" <value> ;

- **ROI Set ()** : Set the ROI and apply the Gain for ROI Gain Feature.
  - ⇨ Read function : "r **rois**";
    Returns the ROI set for the last ROI gain command
  - ⇨ Write function : "w **rois** <val>" with <val> : Hexadecimal combination of Start and Stop address for the ROI (both on 16bits) : *0xStartAdr0xStopAdr*
    - Start address : from 0 to 8190 (0x000 to 0x1FFE)
    - Stop address : from 1 to 8191 (0x001 to 0x1FFF)

<u>ROI Gain : How does it works</u>

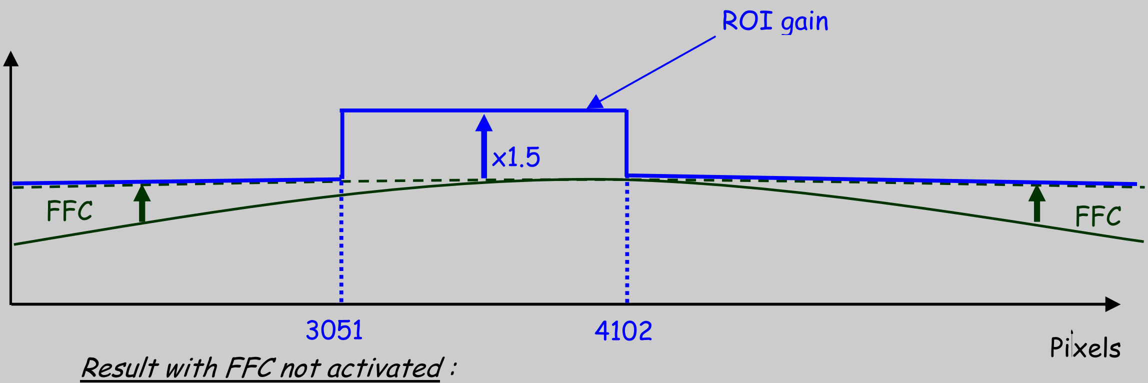
The ROI Gain feature comes in addition with the FFC (it's applied and calculated after).
The maximum complementary Gain ix x2.
It can be applied in 2 commands :
- *First, set the ROI Gain value*
- *Second, set the ROI (Region of Interest).*

⇨ *This second command applies the Gain on the ROI in memory and this is immediately activated.*

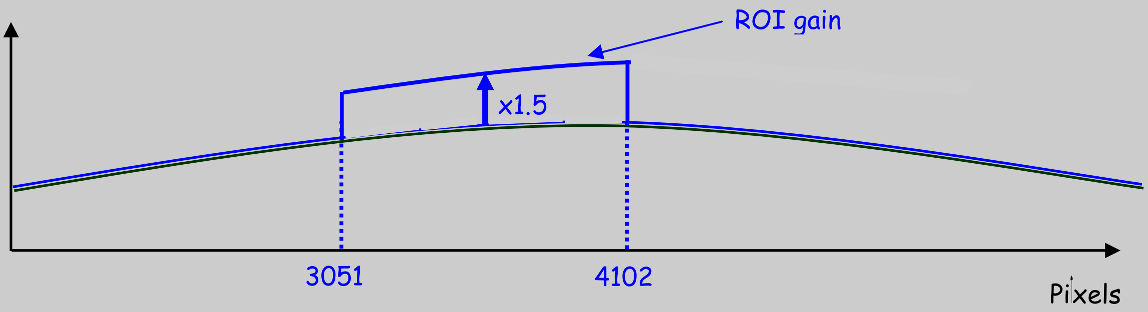
⇨ *The ROI Gain is a "live" feature that can be overlapped but can't be saved in memory.*

*Here is an example to apply a complementary gain of x1,5 (**512**) between the pixels #3051 (0x**0BEB**) and #4102 (0x**1006**), pixels included. The two commands are :*
- ***"w roig 512"***
- ***"w rois 0x0BEB1006"***

<u>Result with FFC activated</u> :



<u>Result with FFC not activated</u> :



5.3.5 Flat Field Correction

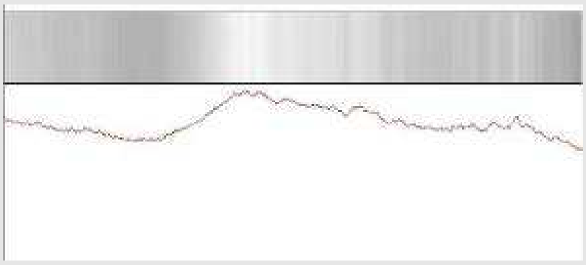
How is performed the Flat Field Correction ?

What is the Flat Field correction (FFC) ?

The Flat Field Correction is a digital correction on each pixel which allows :

- To correct the Pixel PRNU (Pixel Response Non Uniformity) and DSNU (Dark Signal Non Uniformity)
- To Correct the shading due to the lens
- To correct the Light source non uniformity

Before



After

How is calculated / Applied the FFC ?

The FFC is a digital correction on the pixel level for both Gain and Offset.

- Each Pixel is corrected with :
  - An Offset on 8 bits (Signed Int 5.3). They cover a dynamic of ±16LSB in 12bits with a resolution of 1/8 LSB 12bits.
  - A Gain on 14 bits (Unsigned Int 14) with a max gain value of x5(*)

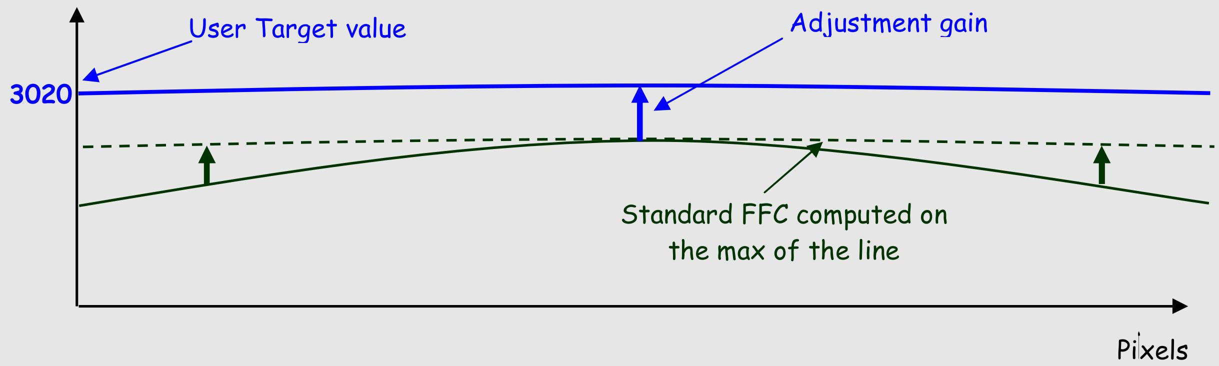
The calculation of the new pixel value is : **$P' = (P + Off).(1 + Gain/1024^{(*)})$**

The FFC processing can be completed with an automatic adjustment to a global target. This function is designed as "**FFC Adjust**". This adjustment to a User target is done by an internal hidden gain which is re-calculated each time the FFC is processed while the FFC adjust function is enabled.

The FFC is always processed with the max pixel value of the line as reference. If enabled, the FFC adjust module (located at the output of the FFC module) calculates the adjustment gain to reach the target defined by the User.

When the FFC result is saved in memory, the adjust gain and target are saved in the same time in order to associate this gain value with the FFC result.

*(*) : Up to the firmware version 1.0.1 (BA0) or 1.0.3A (BA1), the Gain resolution was : **1 + Gain/8192** with a range limited at **x3***



How to perform the Flat Field Correction ?

FPN/DSNU Calibration

- Cover the lens
- Launch the FPN Calibration : Grab and calculation is performed in few seconds

PRNU Calibration

The User must propose a white/gray uniform target to the Camera (not a fixed paper).
The Gain/Light conditions must give a non saturated image in any Line.
The Camera must be set in the final conditions of Light/ Gain and in the final position in the System.
I f required, set a user target for the FFC adjust and enable it.

- White uniform (moving) target
- Launch the FFC
- Enable the FFC
- You can save the FFC result (both FPN+PRNU in the same time) in one of the 4 x FFC User Banks.
- The user target and Gain are saved with the associated FFC in the same memory.

Advices

The ELIIXA+ Cameras have 4 x FFC Banks to save 4 x different FFC calibrations. You can use this feature if your system needs some different conditions of lightning and/or Gain because of the inspection of different objects : You can perform one FFC per condition of Gain/setting of the Camera (4 Max) and recall one of the four global settings (Camera Configuration + FFC + Line Balance) when required.

5.3.5.1 Activation and Auto-Adjust

- **FFC Activation** (*FFCEnable*) : Enable/disable the Flat Field Correction. This command is available in the CommCam "Flat Field Correction" section :

  ⇨ Read function : "**r ffcp**" : Returns the FFC Status (0 if disabled, 1 if enabled)
  ⇨ Write function :
    - "**w ffcp 1**" : Enable the FFC.
    - "**w ffcp 0**" : Disabled the FFC

- **FFC Adjust Function** : This Feature is available in the CommCam "Flat Field Correction/ Automatic Calibration" section :

  - **Gains adjust** (*FFCAdjust*)**:** Enable/Disable the function
    ⇨ Read function : "**r ffad**". Returns the status of the function (0 if disabled)
    ⇨ Write function :
      - "**w ffad 0**" : Disable the FFC Adjust function.
      - "**w ffad 1**" : Enable the FFC Adjust function.

  - **Auto Adjust Target Level** (*FFCAutoTargetLevel*)**:** set the value for the User Target.
    ⇨ Read function : "**r tfad**". Returns the Target value (from 0 to 4095)
    ⇨ Write function : "**w tfad <value>**" : Set the Target Value (in 12bits)
    ⇨

<u>FFC Adjust : A good usage.</u>

When there are several Cameras to set up in a system on a single line, the most difficult is to have a uniform lightning whole along the line.
If each Camera performs its own Flat field correction, relative to the max of each pixel line, the result will be a succession of Camera lines at different levels.
=> The FFC Adjust function allows to set the same target value for all the Cameras in the system and then to get a perfect uniform line whole along the system with a precision of 1 LSB to the Target.
The Maximum correction is x2 the highest value of the line.

The reasonable value for the User Target is not more than around 20% of the max value of the line.

5.3.5.2 Automatic Calibration

- **FPN/DSNU Calibration :**
  - o **FPN Calibration Control** (*FPNCalibrationCtrl*) : Launch or abort of the FPN process for the Offsets calculation. These commands are available in the CommCam "Flat Field Correction / Automatic Calibration " section :

    ⇨ Read function : "**r calo**" : Returns the FPN Calculation Process Status (0 if finished, 1 if processing)

    ⇨ Write function :
    - ▪ "**w calo 1**" : Launch the FPN Calibration Process.
    - ▪ "**w calo 0**" : Abort the FPN Calibration Process.
  - o **FPN Coefficient Reset** (*FPNReset*) : Reset the FPN (Offsets) coefficient in Memory. This command is available in the CommCam "Flat Field Correction / Manual Calibration " section :

    ⇨ Write function : "**w rsto 0**" : Reset (set to 0) the FPN coefficients in memory. This doesn't affect the FFC User Memory Bank but only the active coefficients in Memory.

- **PRNU Calibration :**
  - o **PRNU Calibration Control** (*FFCCalibrationCtrl*) : Launch or abort of the PRNU process for the Gains calculation. This command is available in the CommCam "Flat Field Correction / Automatic Calibration " section :

    ⇨ Read function : "**r calg**" : Returns the PRNU Calculation Process Status (0 if finished, 1 if processing)

    ⇨ Write function :
    - ▪ "**w calg 1**" : Launch the PRNU Calibration Process.
    - ▪ "**w calg 0**" : Abort the PRNU Calibration Process.
  - o **PRNU coefficient Reset** (*PRNUReset*) : Reset the PRNU (Gains) coefficient in Memory. This command is available in the CommCam "Flat Field Correction / Manual Calibration " section :

    ⇨ Write function : "**w rstg 0**" : Reset (set to "x1") the PRNU coefficients in memory. This doesn't affect the FFC User Memory Bank but only the active coefficients in Memory.

Some Warnings can be issued from the PRNU/FPN Calibration Process as "pixel Overflow" of "Pixel Underflow" because some pixels have been detected as too high or too low in the source image to be corrected efficiently.
The Calculation result will be proposed anyway as it's just a warning message.
The Status Register is the changed and displayed in CommCam "Status" section :
Register status is detailed chap §6.3.3.

5.3.5.3 Manual Flat Field Correction

The FFC Coefficients can also be processed outside of the Camera or changed manually by accessing directly their values in the Camera : This is the "Manual" FFC.

In CommCam, the User can access to a specific interface by clicking on "click for extended control" in both "Manual FFC calibration" and "Manual FPN calibration sections" :

This will allow the user to upload/download out/in the Camera the FFC coefficients in/from a binary or text file that can be processed externally.

> It is recommended to setup the baud rate at the maximum value possible (115000 for example) otherwise the transfer can take a long time.

- **FPN coefficients modification :** Direct access to the FPN coefficients for reading or writing.
  The FPN coefficients are read packets of x128 coefficients :
  - ⇨ Read function : "**r ffco <addr>**" : Read 128 consecutive FPN user coefficients starting from **<addr>** address. Returned value is in hexadecimal, without space between values (one unsigned short per coefficient).
  - ⇨ Write function :" **w ffco <addr><val>** : Write 128 consecutive FPN user coefficients starting from the **<addr>** address. **<val>** is the concatenation of individual FPN values, without space between the values (one unsigned short per coefficient).

- **PRNU coefficients modification :** Direct access to the PRNU coefficients for reading or writing.
  The PRNU coefficients are read packets of x128 coefficients :
  - ⇨ Read function : "**r ffcg <addr>**" : Read 128 consecutive PRNU user coefficients starting from **<addr>** address. Returned value is in hexadecimal, without space between values (one unsigned short per coefficient).
  - ⇨ Write function :" **w ffcg <addr><val>** : Write 128 consecutive PRNU user coefficients starting from the **<addr>** address. **<val>** is the concatenation of individual PRNU values, without space between the values (one unsigned short per coefficient).

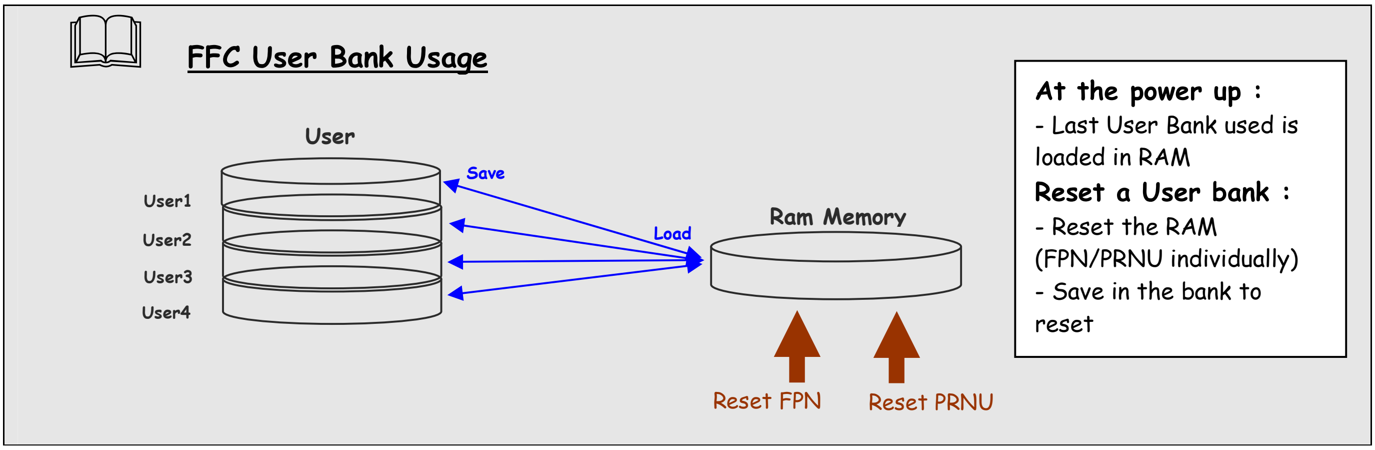
5.3.5.4 FFC User Bank Management

The new-processed FFC values can be saved or restored in/from 4 x User banks.
Both Gains and Offsets in the same time but also the FFC Adjust User target and associated gain.
These functions are available in the Flat Field correction/Save & Restore FFC section :

- **Restore FFC from Bank** (*RestoreFFCFromBank*) : Restore the FFC from a Bank in the current FFC.
  ⇨ Read function : "**r rffc**" : Get the current FFC Bank used
  Returned by the camera : 0 for Factory bank or 1 to 4 for User banks
  ⇨ Write function : "**w rffc <val>**" : Bank <val> 1 to 4 for User banks

  Note : Factory means neutral FFC (no correction).

- **Save FFC in User Bank** (*SaveFFCToBank*) : Save current FFC in User Bank
  ⇨ Can not de read
  ⇨ Write function : "**w sffc <val>**" : User bank <val> if from 1 to 4.



5.3.6 Look Up Table

The User can define an upload a LUT in the Camera that can be used at the end of the processing.
The LUT is defined as a correspondence between each of the 4096 gray levels (in 12 bits) with another outputted value. For example, a "negative" or "reverse" LUT is the following equivalence :

Real value	Output value
0	4095
1	4094
2	4093
…	

Then the size of each value is 12bits but the exchanges with the Application/PC are done on 16 bits :
For 4096 gray levels (from 0 to 4095) the total file size for a LUT is 8Ko.

If this LUT is enables, the "Contrast Expansion" feature (digital Gain and Offset) will be disabled

- **LUT Enable** (*LUTEnable*) : Enable the LUT and sizable the Digital Gain / Offset
  This function is available in the LUT section :.

  ⇨ Read function : "**r lute**" : Get the LUT status
  Returned by the camera : 0 is LUT disabled, 1 if enabled
  ⇨ Write function : "**w lute <val>**" : <val> is 0 for disable, 1 for enable

- **Upload / Download the LUT coefficients :** Direct access to the LUT coefficients for reading or writing. In CommCam, the User can access to a specific interface by clicking on "click for extended control" in the LUT section :

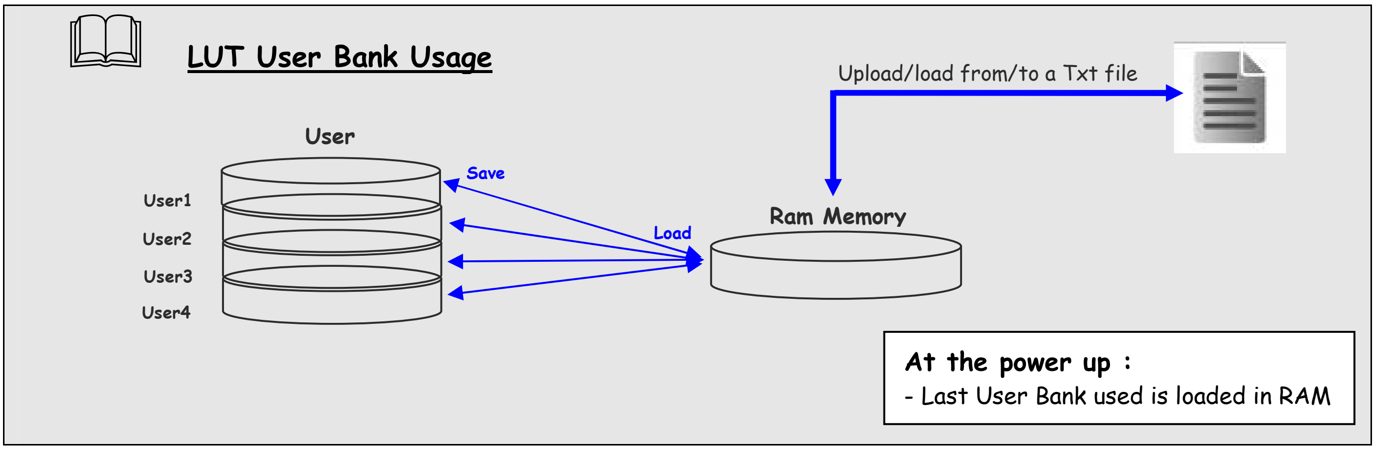
- ⇨ Read function : "**r lutc <addr>**" : Read 128 LUT coefficients starting from address **<addr>** from 0 to 4095-128. Returned value is the concatenation in hexadecimal of individual LUT values, without space between values. (one unsigned short per coefficient)
- ⇨ Write function :" **w lutc <addr><val>** : Write 128 LUT coefficients starting from address **<addr>** form 0 to 4095-128. **<val>** is the concatenation in hexadecimal of individual LUT values, without space between values. (one unsigned short per coefficient)

- **Save & Restore LUT in User Banks** : The LUT loaded in RAM memory can be saved or restored in/from 4 User banks.
  These functions are available in the LUT/Save & Restore LUT Settings section :

  - o **Restore LUT from Bank** (*RestoreLUTFromBank*) : Restore the LUT from a User Bank in the current RAM Memory.
    - ⇨ Read function : "**r rlut**" : Get the current LUT Bank used
      Returned by the camera : 1 to 4 for User banks
    - ⇨ Write function : "**w rlut <val>**" : Bank <val> 1 to 4 for User banks

  - o **Save LUT in User Bank** (*SaveLUTToBank*) : Save current LUT in User Bank
    - ⇨ Can not de read
    - ⇨ Write function : "**w slut <val>**" : User bank <val> if from 1 to 4.

  The bank number <val> is given in (*LUTSetSelector*)



5.3.7 Statistics and Line Profile

This function allows the User to get some statistics on a pre-defined ROI. On request, the Camera acquires and then calculates some key values as the min, the max, the average or the standard deviation in this Region of Interest.
The grab and calculation command and also the collection of the results is not performed in real time as it is done through the serial connection.
This function and the results are available in CommCam in the "Line Profile Average" Section :

- **Line Profile average measurement** (*LineAverageProfile*) : Control the grab and computation of the statistics.
  ⇨ Read function : "**r pixs**" : Get the status of the calculation
  Returned by the camera : 0 : finished, 1: running
  ⇨ Write function :
  - "**w pixs 1**" : Start the accumulation and then the computing
  - "**w pixs 0**" : Abort the computing.

  The Calculated values are detailed as following :
  - **Pixel average Value** (*PixelROIMean*) : Average gray level value calculated on whole Region of interest
    ⇨ Read function : "**r pavr**" : Get the average value
    Returned by the camera : Unsigned format value : U12.4
  - **Pixel Standard deviation** (*PixelROIStandardDeviation*) : standard deviation of all the pixel gray level values of Region of interest
    ⇨ Read function : "**r pstd**" : Get the standard deviation
    Returned by the camera : Unsigned format value : U12.4
  - **Pixel Min value** (*PixelROIMin*) : Minimum gray level pixel value on the whole region of interest.
    ⇨ Read function : "**r pmin**" : Get the Minimum value
    Returned by the camera : Unsigned format value : U12.4
  - **Pixel Max Value** (*PixelROIMax*) : Maximum gray level pixel value on the whole region of interest
    ⇨ Read function : "**r pmax**" : Get the maximum value
    Returned by the camera : Unsigned format value : U12.4

- **Pixel access Line number** (*PixelAccessLineNumer*) : Set the number of lines to accumulate.
  ⇨ Read function : "**r pixl**" : Get the number of line
  Returned by the camera : 1, 256, 512 or 1024
  ⇨ Write function : "**w pixl <val>**" : Set the number of lines. <val> is 1, 256, 512 or 1024.

- **Pixel ROI Start** (*PixelRoiStart*) : Set the Region of Interest start position.
  ⇨ Read function : "**r prod**" : Get the starting pixel
  Returned by the camera : value between 0 and 16383
  ⇨ Write function : "**w prod <val>**" : Set the starting pixel. <val> is between 0 and 16383

- . **Pixel ROI Width** (*PixelRoiWidth*) : Set the Width of the Region of Interest.
  ⇨ Read function : "**r prow**" : Get the width in pixel
  Returned by the camera : value between 1 and 16384
  ⇨ Write function : "**w prow <val>**" : Set the ROI width in pixels. <val> is between 1 and 16384

After performing a line profile measurement, all the values computed which are described below are not refreshed automatically in CommCam : You have to right-click on each value and ask for an individual refresh.

5.3.8 Privilege Level

There are 3 privilege levels for the camera :

- Factory (0) : Reserved for the Factory
- Integrator (1) : Reserved for system integrators
- User (2) : For all Users.

The Cameras are delivered in Integrator mode. They can be locked in User mode and a specific password is required to switch back the Camera in Integrator mode. This password can be generated with a specific tool available from the hotline (hotline-cam@e2v.com)

This function is available in the Privilege section :

- **Privilege level Management** (*PrivilegeLevel*) : Get the current Camera privilege level..
  - ⇨ Read function : "**r lock**" : Get the current privilege
    Returned by the camera : 0 to 2
  - ⇨ Write function : "**w lock <val>**" : <val> is as follow
    - **2** : Lock the Camera in Integrator or "privilege User"
    - **<computed value>** : Unlock the Camera back in Integrator mode

5.3.9 Save & Restore Settings

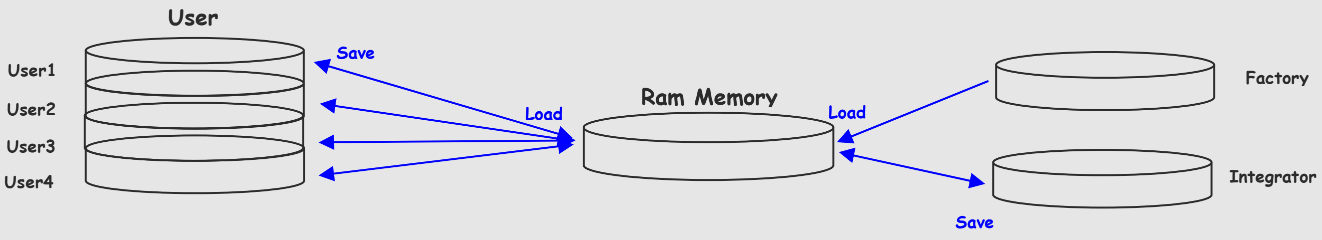
The settings (or Main configuration) of the Camera can be saved in 4 different User banks and one Integrator bank. This setting includes also the FFC and LUT enable
This function is available in the Save & Restore Settings section :

- **Load settings from Bank :** Allows to restore the Camera settings.
  - ⇨ Read function : "**r rcfg**" : Get the current Tap Bank in use
  - ⇨ Write function : "**w rcfg <val>**" : Load settings from bank <val> (0: Factory , 1 to 4 for Users, 5 for Integrator)

- **Save settings to Bank :** Allows to save the Camera settings in User or Integrator Bank
  - ⇨ Write function : "**w scfg <val>**" : Save the current settings in the User bank <val> (1 to 4 for User, 5 for Integrator)

The integrator bank (User Set5) can be written only if the Camera is set in integrator mode (Privilege level = 1). This integrator bank can be used as a « Factory default » by a system integrator.

Configuration Bank Usage



At the power up : Last User Bank used is loaded in RAM
"Integrator" Bank (5) can be locked by switching the Camera in "User" mode (cf : Privilege feature).
Then it can't be saved any more without switching back the Camera in "Integrator" Mode.

6 APPENDIX A: Test Patterns

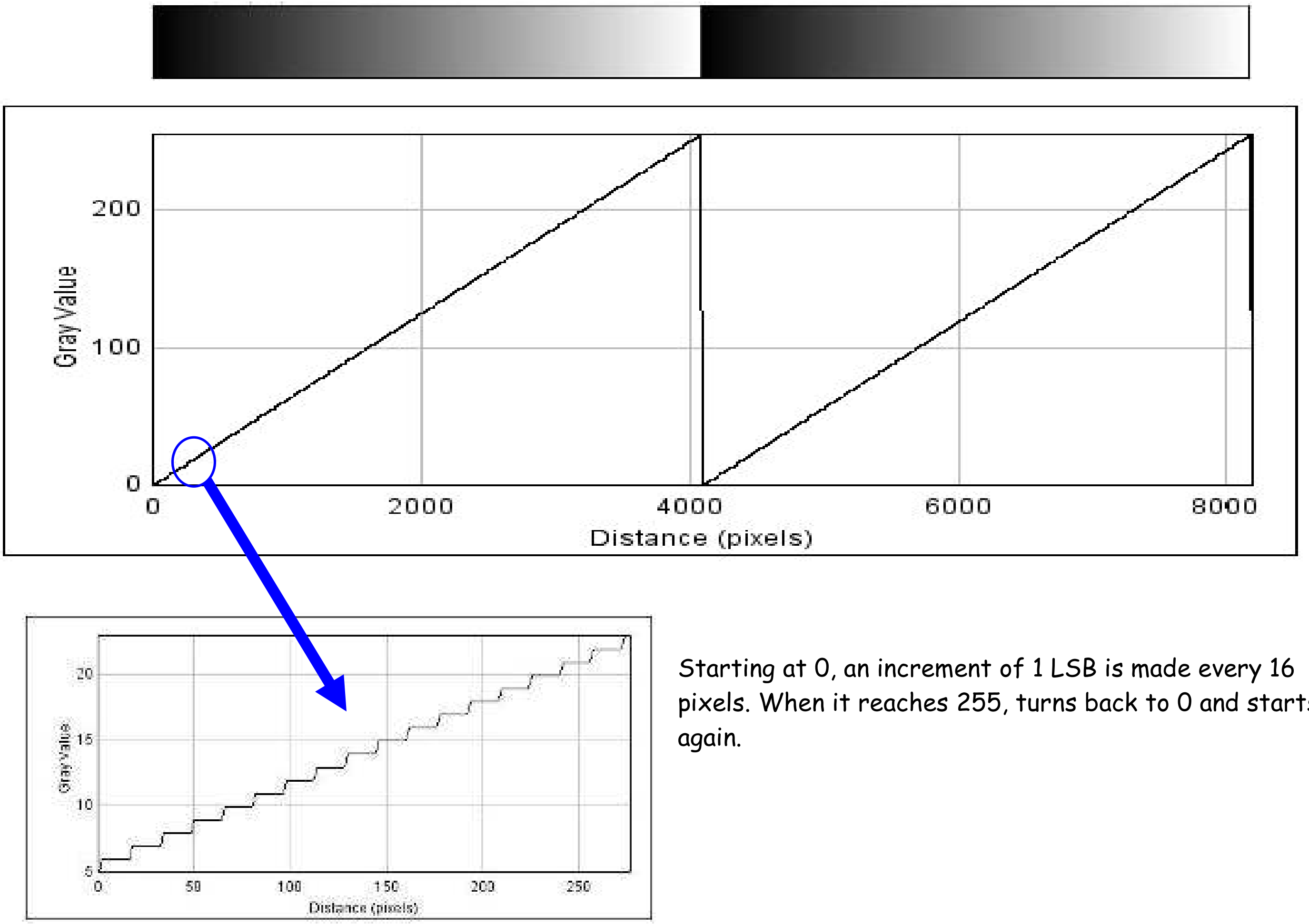
6.1 Test Pattern 1: Vertical wave

The Test pattern 1 is a vertical moving wave : each new line will increment of 1 gray level in regards with the previous one.

- In 12 bits the level reaches 4095 before switching down to 0
- In 10 bits the level reaches 1023 before switching down to 0
- In 8 bits the level reaches 255 before switching down to 0

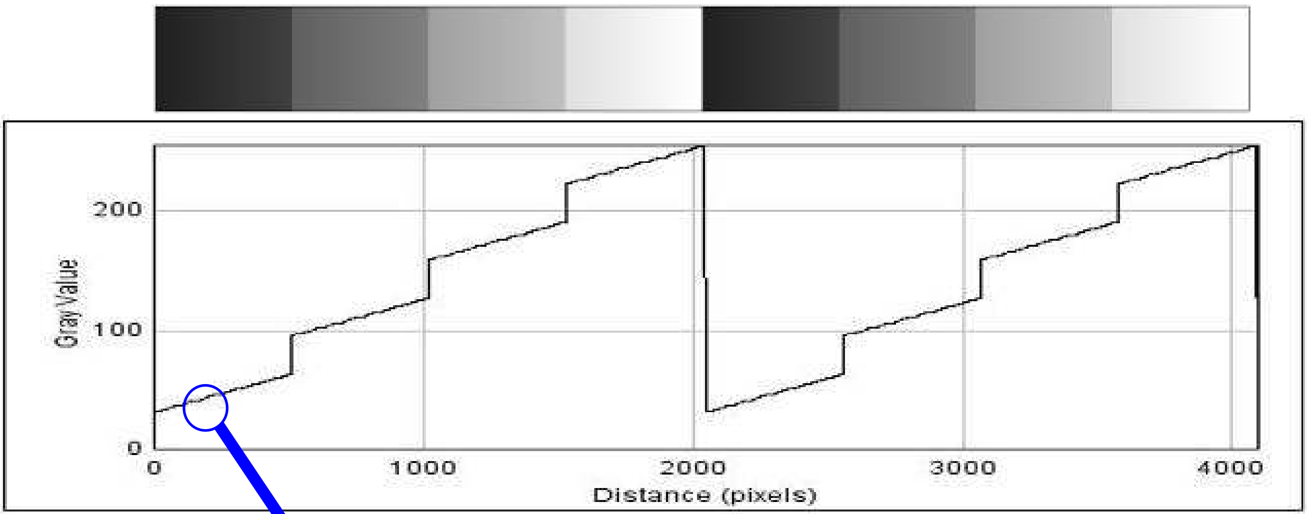
6.2 Test Pattern 2: Fixed Horizontal Ramps

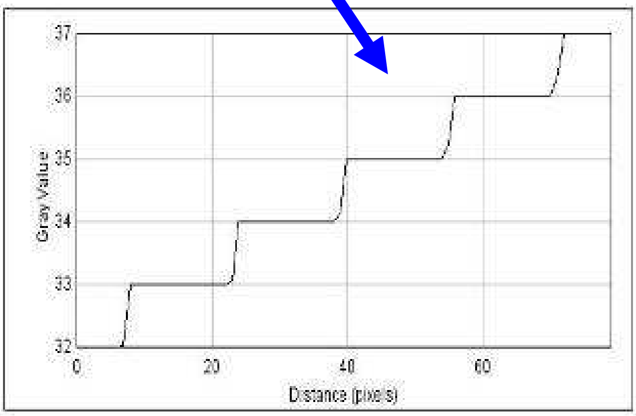
6.2.1 8192 Pixels in 8 bits format



Starting at 0, an increment of 1 LSB is made every 16 pixels. When it reaches 255, turns back to 0 and starts again.

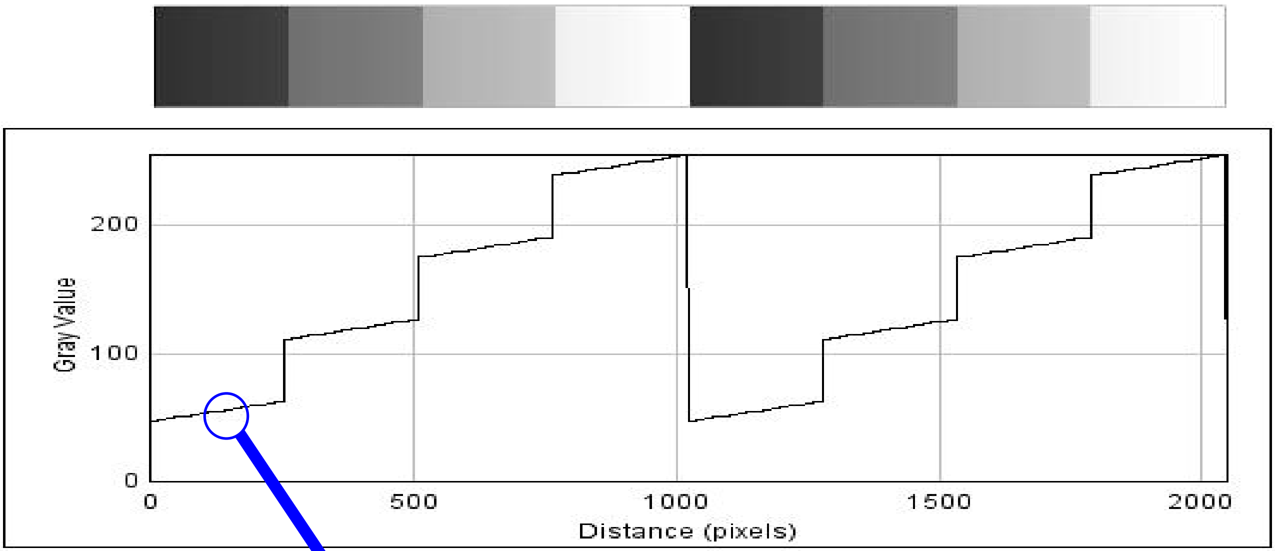
6.2.2 4096 Pixels in 8 bits format

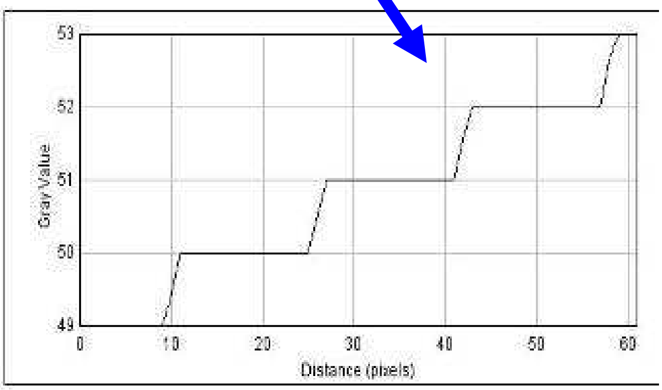




Starting at 32, an increment of 1 LSB is made every 16 pixels.
When reaches 63, jump to 96 then carry on increasing
When reaches 127, jump to 160 then carry on increasing.
When reaches 191, jump to 224 then carry on increasing.
When it reaches 255, turns back to 32 and starts again.

6.2.3 2048 Pixels in 8 bits format

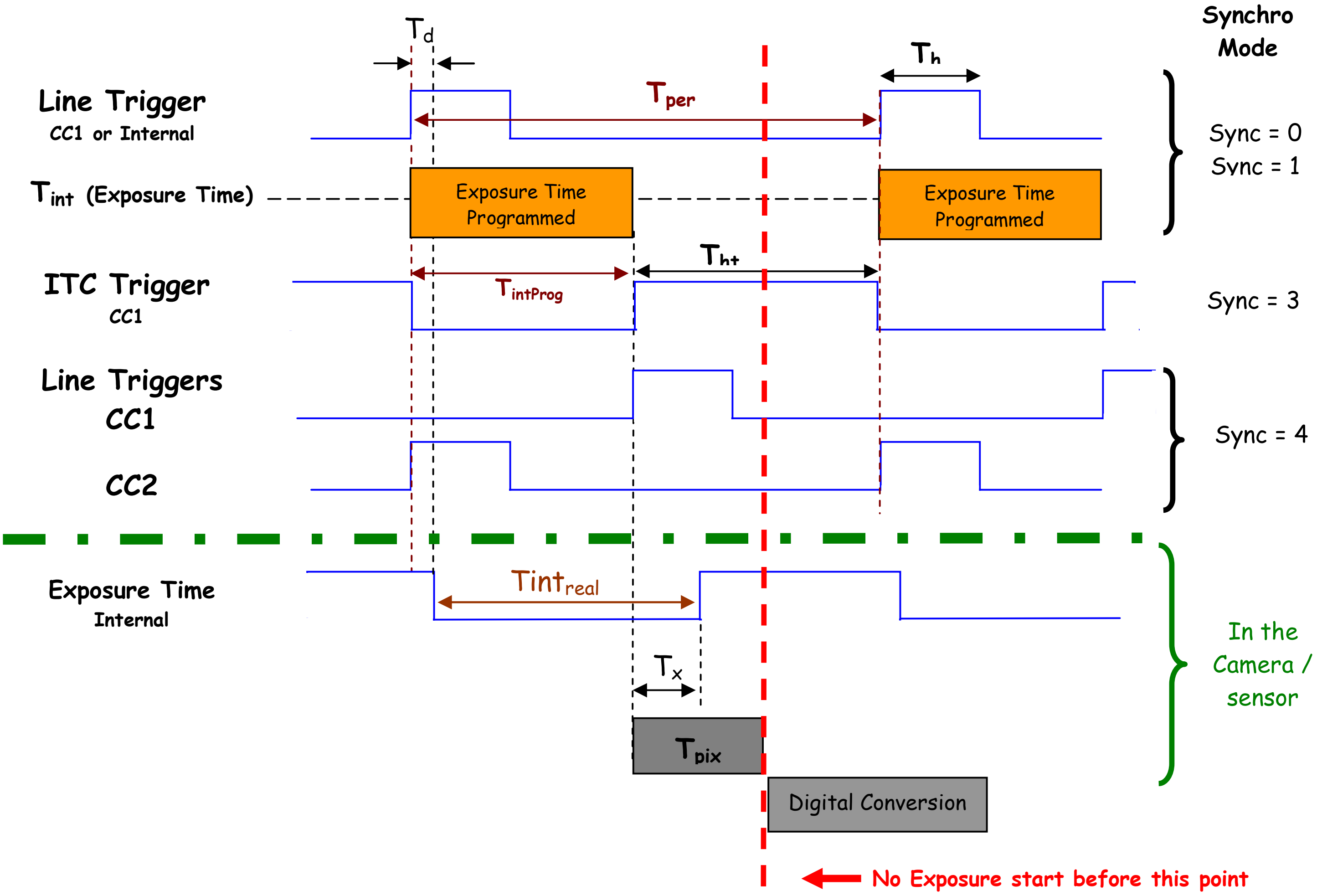




Starting at 48, an increment of 1 LSB is made every 16 pixels.
When reaches 63, jump to 112 then carry on increasing
When reaches 127, jump to 176 then carry on increasing.
When reaches 191, jump to 240 then carry on increasing.
When it reaches 255, turns back to 48 and starts again.

7 APPENDIX B: Timing Diagrams

7.1 Synchronization Modes with Variable Exposure Time



T_{pix} : Timing Pixel. During this uncompressible period, the pixel and its black reference are read out to the Digital converter. During the first half of this timing pixel (read out of the black reference), we can consider that the exposure is still active.

Digital Conversion : During the conversion, the analog Gain is applied by the gradient of the counting ramp (see next chapter : Gain & Offset). The conversion time depends on the pixel format :

- 8 or 10 bits : **6µs**
- 12 bits : **24µs**

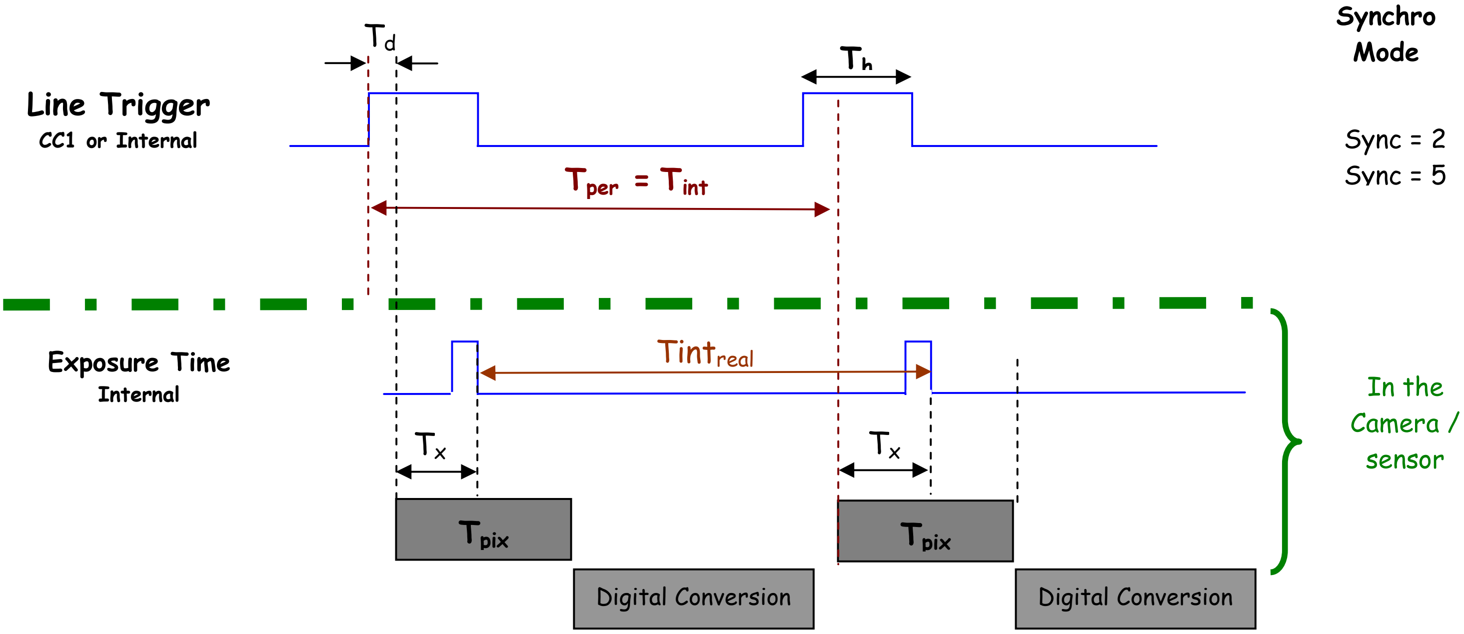
This conversion is done in masked time, eventually during the next exposure period.

T_d : Delay between the Start exposure required and the real start of the exposure.

If T_{per} is the Line Period (internal or external coming from the Trigger line), in order to respect this line Period, the Exposure Time as to be set by respecting : $T_{int} + T_{pix} <= T_{per}$
Then, the real exposure time is : $Tint_{real} = T_{int} + T_x - T_d$.
In the same way, The high level period of the Trig signal in sync=3 mode, $T_{ht} >= T_{pix}$

For a Line Period of *LinePer*, the <u>maximum</u> exposure time possible without reduction of line rate is : $Tint_{max} = T_{per} - T_{pix}$ (T_{pix} is defined above) but the effective Exposure Time will be about $Tint_{real} = T_{int} + T_x - T_d$.

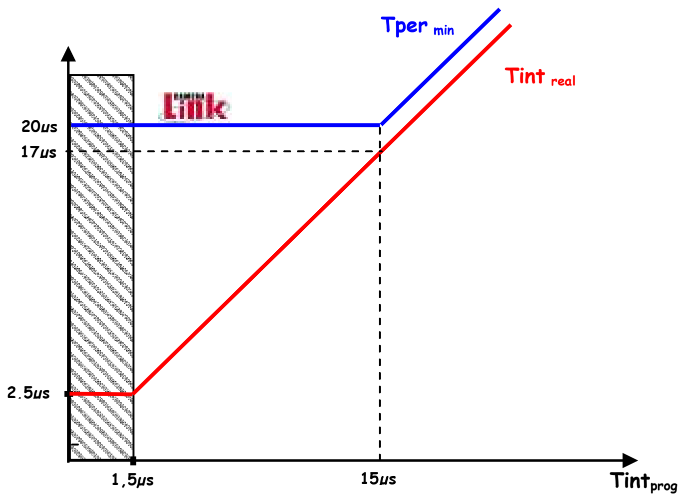
7.2 Synchronisation Modes with Maximum Exposure Time



In these modes, the rising edge of the Trigger (internal or External) starts the readout process (T_{pix}) of the previous integration. The Real exposure time ($Tint_{real}$) is finally equal to the Line Period (T_{per}) even if it's delayed from ($T_x + T_d$) from the rising edge of the incoming Line Trigger.

7.3 Timing Values

Label	Min	Unit
T_{pix}	5	µs
T_x	3,1	µs
T_h	0,120	µs
T_{ht}	T_{pix}	µsec
T_d	1,1	µs

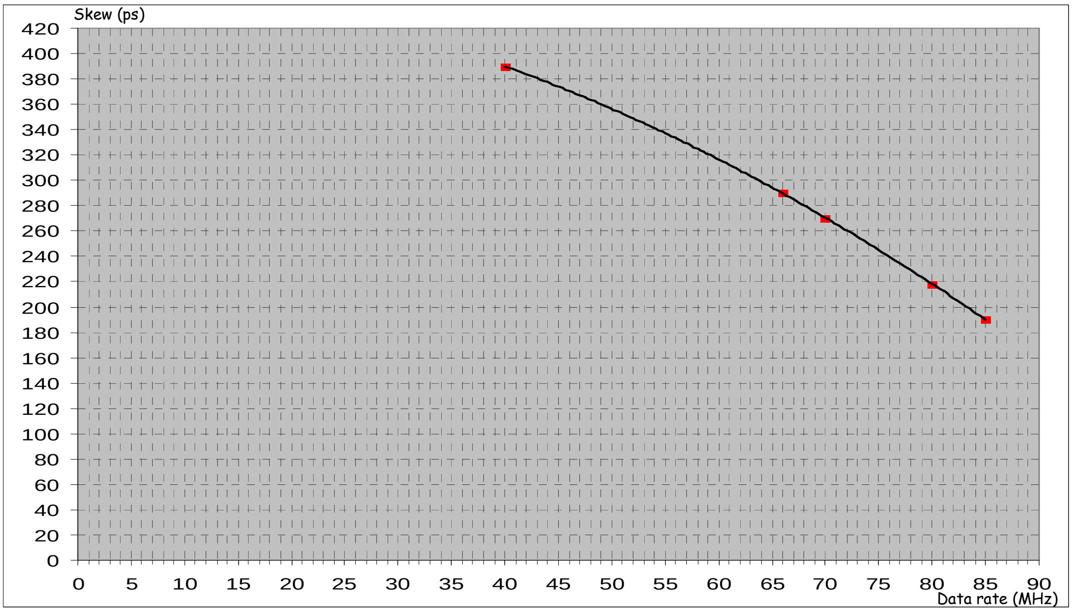


8 APPENDIX C: CameraLink Data Cables

8.1 Choosing the Cable

You may check the compliance of your CameraLink cables with the transportation of the 85MHz data rate.
The main parameter to be checked in the cable specification is the skew (in picoseconds)
This parameter is given for a dedicated maximum value per meter of cable (as max : 50ps/m)

The CameraLink Standards defines the maximum total skew possible for each data rate :



Here is a following example of cable and the cable length limitation in accordance with the standard :

Conductor Size:	28 AWG Stranded
Propogation Velocity:	1.25 ns/ft [4.1 ns/m]
Skew (within pair):	50 ps/meter maximum
Skew (channel skew per chipset):	50 ps/meter maximum

DataRate	Skew	Cable Length
40Mhz	390ps	7,8m
66MHz	290ps	5,8m
70MHz	270ps	5,4m
80MHz	218ps	4,36m
85MHz	190ps	3,8m

8.2 Choosing the Data Rate

Maximum Line Rates tables versus Data rate and Pixel Format

Data Frequency : 85MHz								
Sensor Mode	Base 8-10/12bits		Medium 8-10/12bits		Full 8 tap 8bits		Full + 10 tap 8bits	
	Line Rate Max (kHz)	Tper Min (µs)	Line Rate Max (kHz)	Tper Min (µs)	Line Rate Max (kHz)	Tper Min (µs)	Line Rate Max (kHz)	Tper Min (µs)
1S, 2S, 4S (8K 5µm)	20/20	50/50	40/40	25.0/25.0	80	12.5	100	10
1SB, 2SB (4K 10µm)	40/40	25.0/25.0	80/40	12.5/25.0	100	10.0	100	10
4SB (2K 20µm)	80/40	12.5/25.0	100/40	10.0/25.0	100	10.0	100	10

Data Frequency : 80MHz								
Sensor Mode	Base 8-10/12bits		Medium 8-10/12bits		Full 8 tap 8bits		Full + 10 tap 8bits	
	Line Rate Max (kHz)	Tper Min (µs)	Line Rate Max (kHz)	Tper Min (µs)	Line Rate Max (kHz)	Tper Min (µs)	Line Rate Max (kHz)	Tper Min (µs)
1S, 2S, 4S (8K 5µm)	18.8/18.8	53.2/53.2	37.6/37.6	26.6/26.6	75.1	13,3	93.5	10.7
1SB, 2SB (4K 10µm)	37.6/37.6	26.6/26.6	75.1/40	13,3/25.0	100	10.0	100	10
4SB (2K 20µm)	75.1/40	13.3/25.0	100/40	10.0/25.0	100	10.0	100	10

Data Frequency : 75MHz								
Sensor Mode	Base 8-10/12bits		Medium 8-10/12bits		Full 8 tap 8bits		Full + 10 tap 8bits	
	Line Rate Max (kHz)	Tper Min (µs)	Line Rate Max (kHz)	Tper Min (µs)	Line Rate Max (kHz)	Tper Min (µs)	Line Rate Max (kHz)	Tper Min (µs)
1S, 2S, 4S (8K 5µm)	17.8/17.8	56.4/56.4	35.5/35.5	28.2/28.2	70.4	14.2	87.7	11.4
1SB, 2SB (4K 10µm)	35.5/35.5	28.2/28.2	70.4/40	14.2/25	100	10.0	100	10
4SB (2K 20µm)	70.4/40	14.2/25.0	100/40	10.0/25.0	100	10.0	100	10

Data Frequency : 70MHz								
Sensor Mode	Base 8-10/12bits		Medium 8-10/12bits		Full 8 tap 8bits		Full + 10 tap 8bits	
	Line Rate Max (kHz)	Tper Min (µs)	Line Rate Max (kHz)	Tper Min (µs)	Line Rate Max (kHz)	Tper Min (µs)	Line Rate Max (kHz)	Tper Min (µs)
1S, 2S, 4S (8K 5µm)	16.6/16.6	60.4/60.4	33.1/33.1	30.2/30.2	66.2	15.1	82.6	12.1
1SB, 2SB (4K 10µm)	33.1/33.1	30.2/30.2	66.2/40	15.1/25	100	10.0	100	10
4SB (2K 20µm)	66.2/40	15.1/25.0	100/40	10.0/25.0	100	10.0	100	10

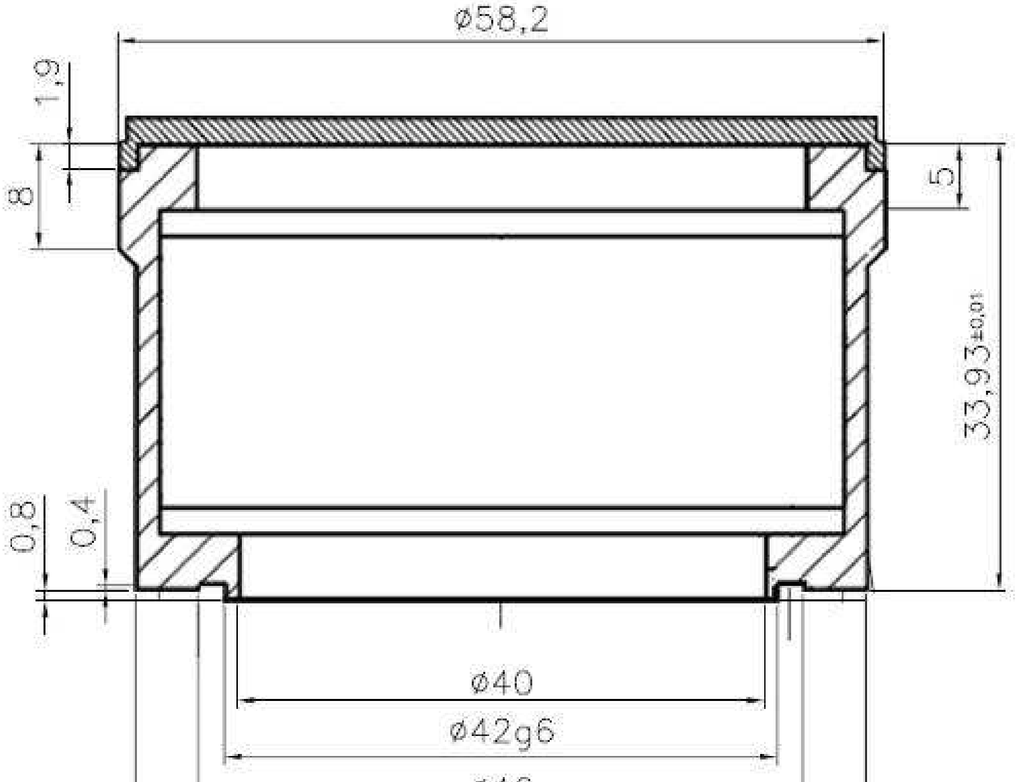
Data Frequency : 65MHz								
Sensor Mode	Base 8-10/12bits		Medium 8-10/12bits		Full 8 tap 8bits		Full + 10 tap 8bits	
	Line Rate Max (kHz)	Tper Min (µs)	Line Rate Max (kHz)	Tper Min (µs)	Line Rate Max (kHz)	Tper Min (µs)	Line Rate Max (kHz)	Tper Min (µs)
1S, 2S, 4S (8K 5µm)	15.5/15.5	64.8/64.8	30.9/30.9	32.4/32.4	61.7	16.2	76.9	13
1SB, 2SB (4K 10µm)	30.9/30.9	32.4/32.4	61.7/40	16.2/25.0	100	10.0	100	10
4SB (2K 20µm)	61.7/40	16.2/25.0	100/40	10.0/25.0	100	10.0	100	10

Data Frequency : 60MHz								
Sensor Mode	Base 8-10/12bits		Medium 8-10/12bits		Full 8 tap 8bits		Full + 10 tap 8bits	
	Line Rate Max (kHz)	Tper Min (µs)	Line Rate Max (kHz)	Tper Min (µs)	Line Rate Max (kHz)	Tper Min (µs)	Line Rate Max (kHz)	Tper Min (µs)
1S, 2S, 4S (8K 5µm)	14.5/14.5	69.2/69.2	28.9/28.9	34.6/34.6	57.8	17.3	71.9	13.9
1SB, 2SB (4K 10µm)	28.9/28.9	34.6/34.6	57.8/40	17.3/25	100	10.0	100	10
4SB (2K 20µm)	57.8/40	17.3/25	100/40	10.0/25.0	100	10.0	100	10

9 APPENDIX D: Lens Mounts

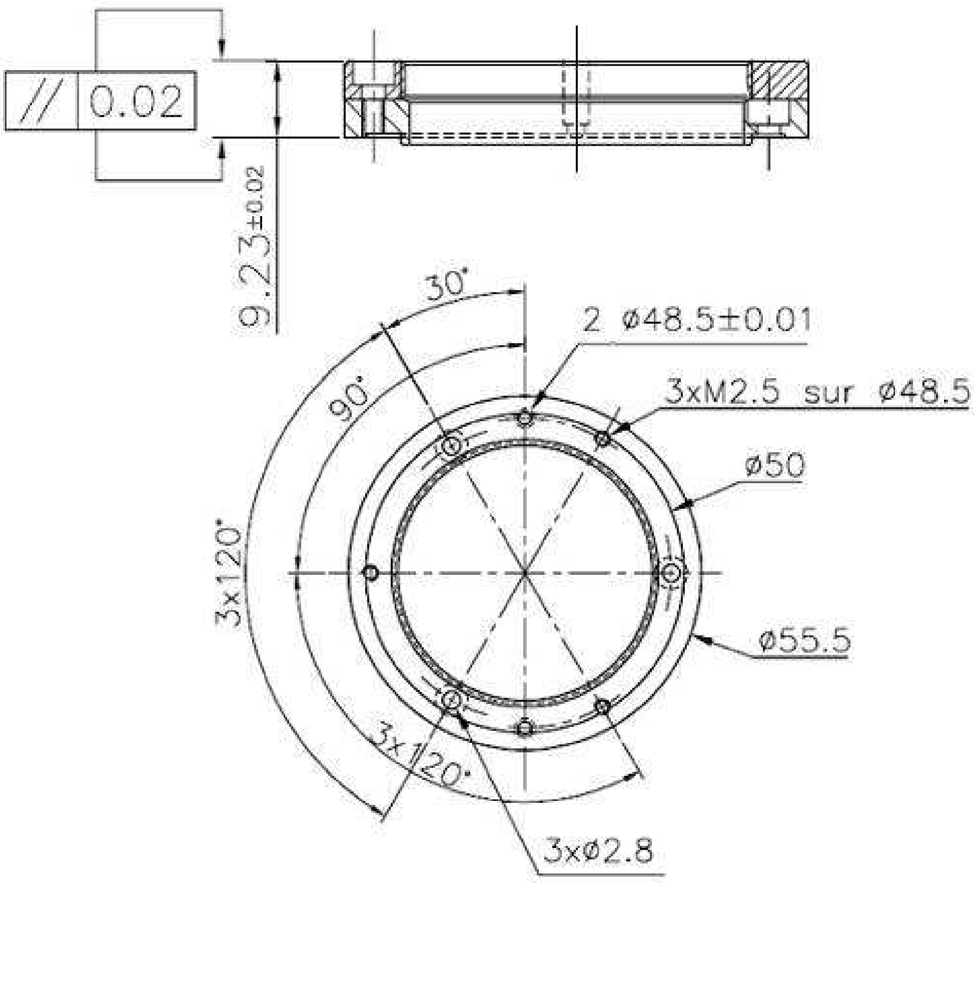
9.1 F-Mount

F Mount : Kit10 (Part number EV71KFPAVIVA-ABA)



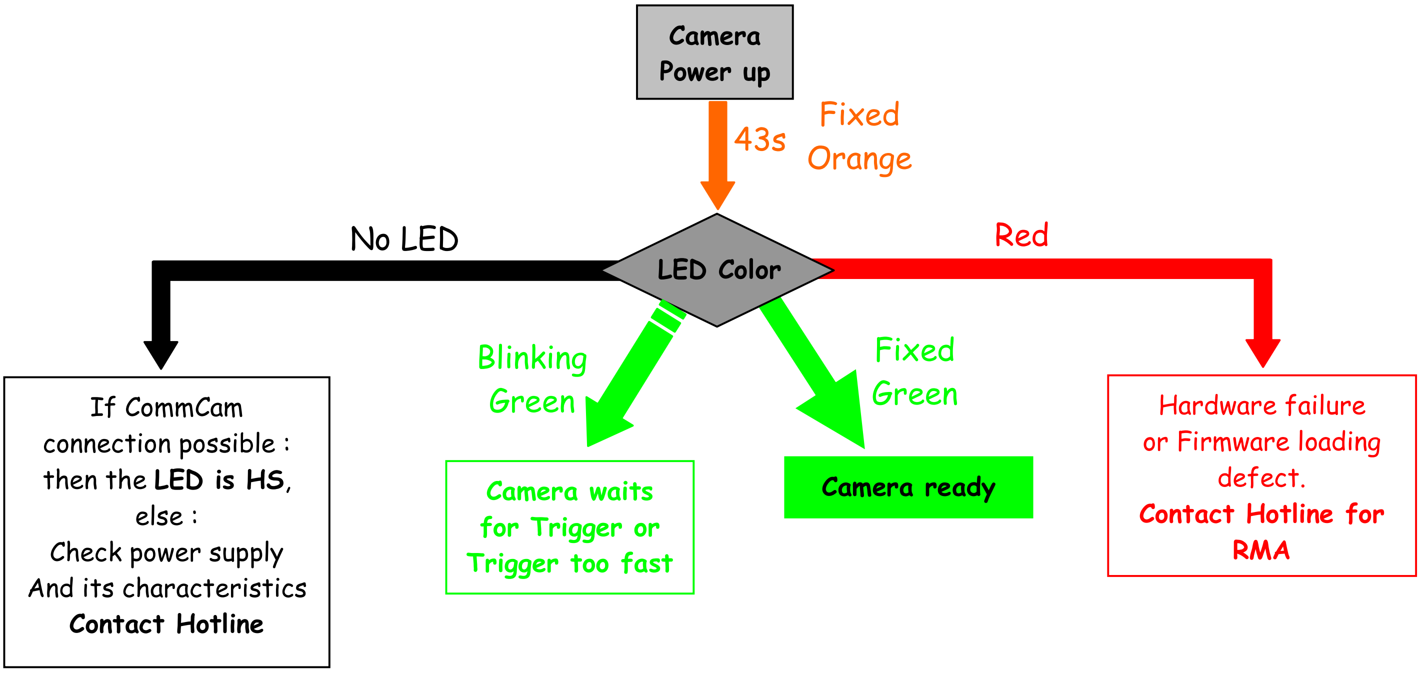
9.2 T2 & M42x1 Mounts

M42x0,75 (T2 Mount) : Kit30 (Part number AT71KFPAVIVA-AKA)
M42x1 Mount : Kit40 (Part number AT71KFPAVIVA-ADA)



10 APPENDIX E: TROUBLESHOOTING

10.1 Camera



10.2 CommCam Connection

Refer to CommCam software Help for the connection issues.

11 APPENDIX F: Revision History

11.1 Device Control

Feature	CL Command	Description
DeviceVendorName	r vdnm	Get camera vendor name as a string (32 bytes long including '\0')
DeviceModelName	r mdnm	Get camera model name as a string (32 bytes long including '\0')
DeviceFirmwareVersion	r dfwv	Get camera synthetic firmware version (PKG version) as a string (32 bytes long including '\0')
DeviceVersion	r dhwv	Get camera version as a string (hardware version) (32 bytes long including '\0')
DeviceManufacturerInfo	r idnb	Get camera ID as a string (48 bytes long including '\0')
DeviceUserID	r cust	Get device user identifier as a string (16 bytes long including '\0')
	w cust <idstr>	Set camera identifier to <idstr>
DeviceID	r deid	Read Serial Nb
ElectronicBoardID	r boid	Read Electronic Board ID
DeviceSFNCVersionMajor	Xml Virtual	
DeviceSFNCVersionMinor	Xml Virtual	
DeviceSFNCVersionSubMinor	Xml Virtual	

11.2 Image Format

Feature	Command	Description
SensorWidth	r snsw	Get sensor physical width.
SensorHeight	Xml virtual	
WidthMax	Map on SensorWidth	
HeightMax	Xml virtual	
Height	Xml virtual	
Width	Xml virtual	Depends on (OuputRegion, OuputRegionWidth) and SensorWidth
SensorMode	r smod	Get sensor mode
	w smod 0	Set sensor mode to DualLine "1S
	w smod 1	Set sensor mode to MultiLine "2S
	w smod 2	Set sensor mode to QuadriLine "4S"
	w smod 3	Set sensor mode to MonoLine "1SB
	w smod 4	Set sensor mode to DualLine "2SB"
	w smod 5	Set sensor mode to DualLine "4SB"
MultiLineGain	r mlig	Get MultiLine gain
	w mlig 0	Set MultiLine gain to "x1"
	w mlig 1	Set MultiLine gain to "x1/2" (not available if SensorMode = 0 or = 5 ("1S"/"4S" modes)
ScanDirection	r scdi	Get scan direction
	w scdi 0	Set scan direction to "forward"
	w scdi 1	Set scan direction to "reverse"
	w scdi 2	Set scan direction to "Externally controlled direction via CC3 Camera Link (CC3=0 forward, CC3=1 reverse)"
ReverseReading	r revr	Get reverse reading value
	w revr 0	Set reverse reading to "disable"
	w revr 1	Set reverse reading to "enable"

Feature	Command	Description
OutputMode	r mode	Get output mode (CameraLink configuration and CMOS sensor resolution)
	w mode 0	Set output mode to "Medium4Outputs8bits"
	w mode 1	Set output mode to "Medium4Outputs12bits"
	w mode 2	Set output mode to "Full8Outputs8bits"
	w mode 3	Set output mode to "FullPlus10Outputs8bits"
OutputFrequency	r clfq	Get Camera Link frequency
	w clfq 0	Set Camera Link frequency to 85MHz
	w clfq 1	Set Camera Link frequency to **60MHz** (available only for 8k sensor)
	w clfq 2	Set Camera Link frequency to **65MHz** (available only for 8k sensor)
	w clfq 3	Set Camera Link frequency to **70MHz** (available only for 8k sensor)
	w clfq 4	Set Camera Link frequency to **75MHz** (available only for 8k sensor)
	w clfq 5	Set Camera Link frequency to **80MHz** (available only for 8k sensor)
TestImageSelector	r srce	Get test (output FPGA) image pattern
	w srce 0	Set test (output FPGA) image pattern to "Off", processing chaine activated
	w srce 1	Set test (output FPGA) image pattern to "GreyHorizontalRamp", processing chaine desactivated
	w srce 2	Set test (output FPGA) image pattern to "White pattern", processing chaine desactivated
	w srce 3	Set test (output FPGA) image pattern to "gray pattern", processing chaine desactivated
	w srce 4	Set test (output FPGA) image pattern to "Black pattern", processing chaine desactivated
	w srce 5	Set test (output FPGA) image pattern to "GreyVerticalRampMoving", processing chaine desactivated

11.3 Synchro and Acquisition

Feature	Commands	Description
LinePeriod	r tper	Get current line period
	w tper <val>	Set line period, from from 1 (0,1µs) to 65535 (6553,5µs), step 1 (0,1µs)
LinePeriodMin	r tpmi	Get current line period min (0..65535 step 0,1µs)
AcquisitionLineRate	Xml Virtual	= 1 / LinePeriod en Hertz
ExposureTime~~Abs~~	r tint	Get exposure time
	w tint <val>	Set exposure time, from 1 (0,1µs) to 65535 (6553,5µs), step 1 (0,1µs)
TriggerPreset	r sync	Get trigger preset mode
	w sync 0	Set trigger preset mode to Freerun timed mode, with exposure time and line period programmable
	w sync 1	Set trigger preset mode to Triggered mode with exposure time settings
	w sync 2	Set trigger preset mode to Triggered mode with maximum exposure time
	w sync 3	Set trigger preset mode to Triggered mode with exposure time controlled by one signal
	w sync 4	Set trigger preset mode to Triggered mode with exposure time controlled by two signals
	w sync 5	Set trigger preset mode to Freerun mode, with max exposure time and programmable line period

11.4 Gain & Offset

Feature	Commands	Description
GainAbs **GainSelector= AnalogAll**	r pamp	Get the current pre-amp gain
	w pamp <val>	Set pre amplifier gain to: 0 (-12dB), 1 (-6dB), 2 (0dB) (analog gain) Change balances and compensation
GainAbs **GainSelector= gainAll**	r gain	Get current digital gain
	w gain <val>	Set gain from 0dB(0) to +8 dB (6193)
Gain Abs **GainSelector=DigitalAll**	r gdig	Get contrast expansion digital gain
	w gdig <val>	Set contrast expansion digital gain from 0 (0 dB) to 255 (+14 dB), step 1 (TBD dB)
BlackLevelRaw **BlackLevelSelector=All**	r offs	Get common black level.
	w offs <val>	Set common black from -4096 to 4095, step 1
GainAbs **GainSelector=DigitalTap<j>**	r fga<j> <val>	Get tap<j> digital gain. Dynamically updated on AnalogAll gain changes
	w fga<j> <val>	Set tap<j> digital gain from -128 to 127 by step 1 (0.0021dB). Dynamically updated on AnalogAll gain changes
ROI Gain Set	r roig	Read the last ROI gain set
	w roig <val>	Set the Value for the ROI Gain : <val> from 0 to 2047 : U1.11 (1+coeff/1024) => x1..x1.999877 step 1/1024
ROI Set	r rois	Read the last ROI set
	w rois <val>	Set the ROI and applies the ROI Gain on it. <val> is a combination of Start and Stop Addresses for ROI. - Start Address : From 0 to 8190 (0x0000 to 0x1FFE) - Stop Address : From 1 to 8191 (0x0001 to 0x1FFF)

11.5 Flat Field Correction

Feature	Commands	Description
FFCEnable	r ffcp	Get Flat Field Correction processing status
	w ffcp 0	Disable Flat Field Correction ("False")
	w ffcp 1	Enable Flat Field Correction ("True")
FPNReset	w rsto 0	Reset FPN coefficients
PRNUReset	w rstg 0	Reset PRNU coefficients
No direct feature	r ffco <addr>	Read 128 Fpn coefficients starting from address <addr>. Return value is in hexadecimal, without space between values (one unsigned short per coef). Format: S9.1 => -256..+255.5 step 1/2
	w ffco <addr> <val>	Write 128 Fpn coefficients (straight to FPGA) starting from address <addr>. <val> is the concatenation of individual Fpnvalue, without space between values.
No direct feature	r ffcg <addr>	Read 128 Prnu coefficients (straight from FPGA) starting from address <addr>. Return value is in hexadecimal, without space between values. (one unsigned short per coef) U1.13 (1+coeff/8192) => x1..x2.999877 step 1/8192
	w ffcg <addr> <val>	Write 128 Prnu coefficients (straight to FPGA) starting from address <addr>. <val> is the concatenation of individual PRNUvalue, without space between values.
FFCCalibrationCtrl	r calg	Get the PRNU calibration status
	w calg 0	Abort PRNU calibration by setting it to "Off" (no effect if already stopped)
	w calg 1	Launch PRNU calibration by setting it to "Once" (no effect if already launched)
PrnuCalibrationCtrl	r calo	Get the fpn calibration status
	w calo 0	Abort fpn calibration by setting it to "Off" (no effect if already stopped)

Feature	Commands	Description
	w calo 1	Launch fpn calibration by setting it to "Once" (no effect if already launched)
FFCAdjust	r ffad	Get ffc adjust state
	w ffad 0	Disable ffc adjust
	w ffad 1	Enable ffc adjust
FFCAutoTargetLevel	r tfad	Get the FFC target adjust level
	W tfad <val>	Set FFC target adjust level, from 0 to 4095, step 1

11.6 LUT

Feature	Commands	Description
LUTEnable	r lute	Get LUT status
	w lute 0	Disable LUT ("False")
	w lute 1	Enable LUT ("True")
No direct feature	r lutc <addr>	Read 128 LUT coefficients starting from address <addr> from 0 to 4095-128. Return value is in hexadecimal, without space between values. (one unsigned char per coef)
	w lutc <addr> <val>	Write 128 LUT coefficients starting from address <addr> from 0 to 4095-128. <val> is the concatenation of individual LUTvalue, without space between values.

11.7 Save and Restore

Feature	Commands	Description
UserSetLoad	r rcfg	Get the current user configuration bank (saved or restored)
	w rcfg <val>	Restore current UserSet from UserSet bank number <val>, from 0 to 5; <val> comes from UserSetSelector.
UserSetSave	w scfg <val>	Save current UserSet to UserSet bank number <val>, from 1 to 5; <val> comes from UserSetSelector. 0 cannot be saved. 5 (Integrator) can't be saved in User mode
UserSetControl	Xml virtual	
RestoreLUTFromBank	r rlut	Get the current LUT bank (saved or restore)
	w rlut <val>	Restore current LUT from LUT bank number <val>, from 1 to 4; <val> comes from LUTSetSelector.
SaveLUTToBank	w slut <val>	Save current LUT to LUT FFC bank number <val>, from 1 to 4; <val> comes from LUTSetSelector.
RestoreFFCFromBank	r rffc	Get the current FFC bank (save or restore)
	w rffc <val>	Restore current FFC (including FPN and FFCGain) from FFC bank number <val>, from 1 to 4; <val> comes from UserFFCSelector (XML feature).
SaveFFCToBank	w sffc <val>	Save current FFC (including FPN and FFCGain) to FFC bank number <val>, from 1 to 4; <val> comes from FFCSelector (XML feature).

11.8 CAMERA STATUS

Feature	Commands	Description
PrivilegeLevel	r lock	Get camera running privilege level 0 = Privilege Factory 1 = Privilege Advanced User 2 = Privilege User
ChangePrivilegeLevel	w lock 1	Lock camera privilege to "Advanced User"
	w lock 2	Lock camera privilege to "User"
	w lock <val>	Unlock camera privilege depending on <val> (min=256; max=2^{32}-1)
DeviceTemperature	r temp	Read Mainboard internal temperature (format signed Q10.2 = signed 8 bits, plus 2 bits below comma. Value from -512 to +511) in °C
DeviceTemperatureSelector	Xml Virtual	
Standby	r stby	Read Standby state (CMOS sensor)
	w stby 0	Disable standby mode ("False")
	w stby 1	Enable standby mode ("True"), no more video available but save power and temperature
	r stat	Get camera status (see below for details)
StatusWaitForTrigger		Bit 0: true if camera waits for a trigger during more than 1s
Satus trigger too fast		Bit 1: true if camera trigger is too fast
StatusWarningOverflow		Bit 8: true if a an overflow occurs during FFC calibration or Tap balance (available only for integrator/user mode)
StatusWarningUnderflow		Bit 9: true if a an underflow occurs during FFC calibration or Tap balance (available only for integrator/user mode)
Cc3 Scrolling direction		Bit 11: 0 : forward, 1: reverse
StatusErrorHardware		Bit 16 : true if hardware error detected

11.9 Communication

Feature	Commands	Description
ComBaudRate	r baud	Get current baud rate (This feature is not saved in camera)
	w baud 1	Set baud rate to "9600Bds"
	w baud 2	Set baud rate to "19200Bds"
	w baud 6	Set baud rate to "57600Bds"
	w baud 12	Set baud rate to "115200Bds"

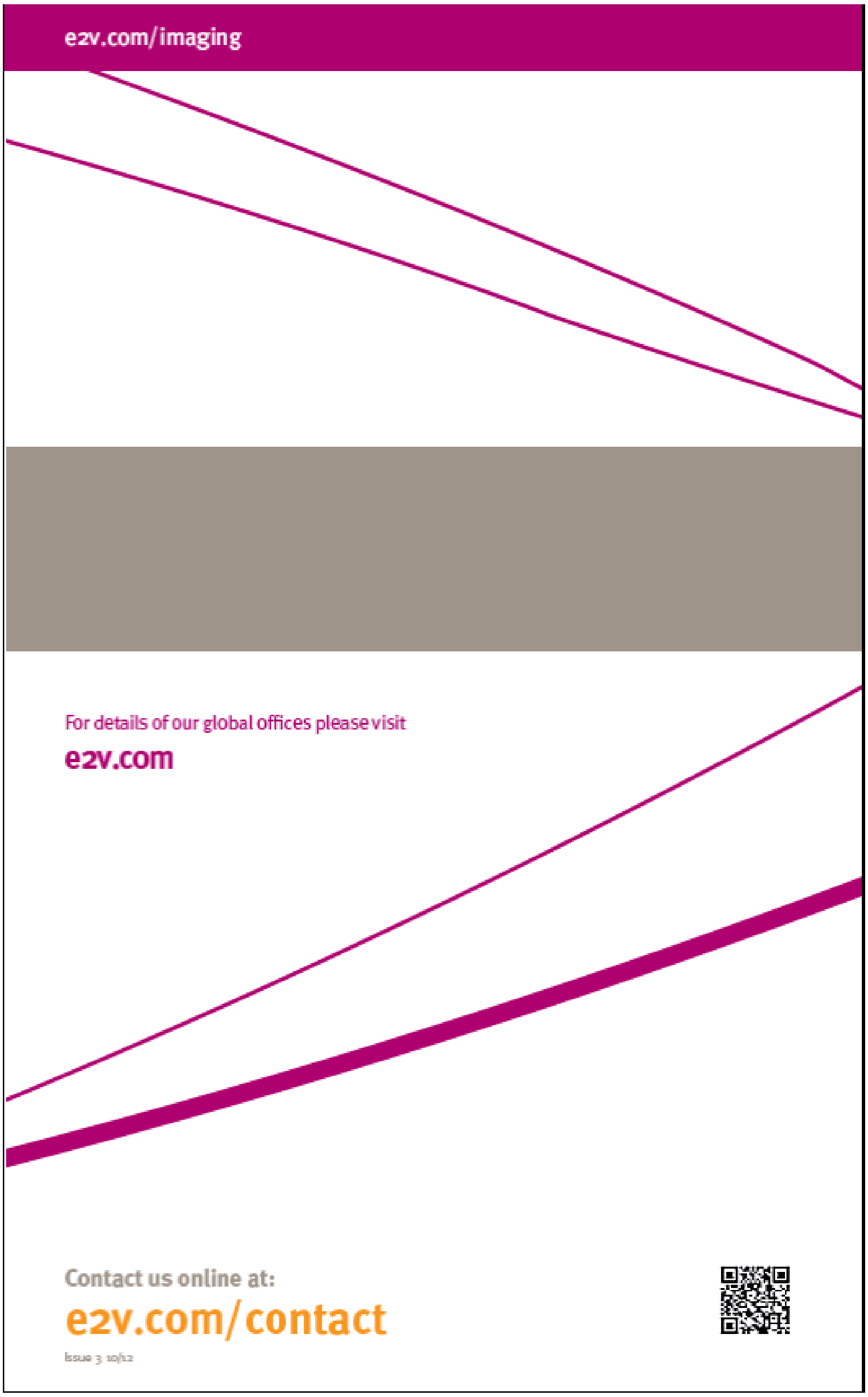
11.10 Line Profile Average

Feature	Commands	Description
LineAverageProfile	r pixs	Get the line Line Average Profile status - 1 : running - 0 : finished
	w pixs 0	Abort the Line Average Profile
	w pixs 1	Run the Line Average Profile
PixelAccessLineNumer	r pixl	Get the number of line for average
	w pixl <val>	Set the number of line to accumulate - <val> : 1,256,512,1024
No direct feature	r pixv <addr>	Read 128 pixel values starting from address <addr>, from SensorWidth-128-1. Return value is in hexadecimal, without space between values. (one unsigned short per coef)

Feature	Commands	Description
PixelRoiStart	r prod	Get Roi start
	w prod <val>	Set Roi start for pixel statistic computing (0 to SensorWidth -1-1)
PixelRoiWidth	r prow	Get Roi width
	W prow <val>	Set Roi width for pixel statistic computing (1 to SensorWidth)
PixelROIMean	r pavr	Get ROI Mean (format U12.4)
PixelROIStandardDeviation	r pstd	Get ROI Stand deviation (format U12.4)
PixelROIMin	r pmin	Get ROI Min (format U12.4)
PixelROIMax	r pmax	Get ROI Max (format U12.4)

12 APPENDIX G: Revision History

Manual Revision	Comments / Details	Firmware version	1st CommCam compliant Version
Rev A	First release (Base Mode and Quarter Balance not available) Version BA0 Version BA1	 1.0.0B 1.0.1A	**2.1.4**
Rev B	- Base mode - Tap Gains Balance Version BA0 Version BA1	 1.0.1 1.0.3A	**2.1.5**
Rev C	- ROI Gain and New FFC - Correction of the STB Full Exposure Control Mode Version BA0 Version BA1	 1.0.2 1.0.4A	**2.1.7**
Rev D	- Characterization and improvement of the Forward / Reverse feature Version BA0 Version BA1	 1.0.3 1.0.6	**2.1.7**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Issue 3 10/12